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GROWTH OF DISPIRA CORNUTA IN ARTIFICIAL CULTURE[1]

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(WITH PLATE 41)

Dispira cornuta van Tiegh. has been regarded hitherto as an obligate parasite on members of the Mucorales. This is due, probably to the fact that van Tieghem (**10**) in the initial study of this fungus found that the spores in hanging drops of nutrient media enlarged, produced short germ tubes and then remained quiescent.

The writer was unsuccessful in his initial attempts to culture the organism without a host on such common laboratory media as potato, oatmeal, bean pod, nutrient agars because, as he learned later, these media are unsuitable for its growth. Failing to culture the fungus on these media, an attempt was made to cultivate it on substances of high protein content to which no agar had been added. Previously Sawyer (**8**) demonstrated that this type of media was suitable for cultivation of certain parasites on animals as species of *Entomophthora* and *Empusa*. And on this type of media, *D. cornuta* was cultivated successfully without a host for the first time. The results of this investigation are presented in the following paper since they may interest others studying fungi in culture.

[1] Contribution from the Laboratories of Cryptogamic Botany, Harvard University, No. 107.

[2] The writer wishes to express his appreciation to Dr. W. H. Weston, Jr., at whose suggestion this research was undertaken, for stimulating encouragement and helpful criticism during the progress of this investigation and the preparation of the manuscript.

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HISTORY OF THE FUNGUS

Dispira cornuta was reported originally from France in 1875 by van Tieghem (**10**). Later (1895) a fungus similar to *D. cornuta* was described from North America as *D. americana* by Thaxter (**9**). However, in 1906, Bainier (**1**) emended van Tieghem's description and illustrations and showed that *D. cornuta* and *D. americana* were identical. More recently (1926) Elliott (**5**) described from Great Britain *D. circinata* which differed from *D. cornuta* chiefly in that the upright, fertile hyphae branched three to six times (later states five to six) instead of twice as is typical of *D. cornuta*. From various sources, the writer has collected six times a fungus which agrees with Bainier's (**1**) description and illustrations of *D. cornuta*. Cultures isolated from these collections exhibited considerable proliferation of the heads, the sterile horn-like projections at the base of the fertile heads, and the sterigmata. Also the fertile hyphae branched dichotomously as well as pseudodichotomously. They produced not only two branches (PLATE 41, FIGS. 2, 3) as described for *D. cornuta* but also three to five branches as illustrated for *D. circinata*. Therefore, with these variations in mind, it seems justifiable to assume that *D. cornuta, D. americana* and *D. circinata* are synonyms for the same fungus and the name *D. cornuta* van Tiegh. should be used because of its priority.

MATERIALS AND METHODS

Collections of *D. cornuta* on its natural hosts were secured easily from hog and rat dung placed on moist sphagnum in damp chambers. In these cultures, the first of the coprophilous Mucorales to appear were species of *Pilobolus*, then species of *Mucor* on which, after about ten days, *Dispira cornuta* developed. Fragments of *Mucor* (PLATE 41, FIG. 3) with its parasite were transferred to tubes of agar media and allowed to stand until the sporangiophores of *Dispira* had raised themselves well above the host. Parts of the sporangiophores together with spores (PLATE 41, FIG. 4) were then removed with a fine platinum needle to various media. At first, these fragments were transferred to agar media which were suitable for the growth of the host but not for the parasite. To insure that only *D. cornuta* was present

in these cultures, they were kept under observation for at least ten days before transfers were made from them to different media. It was found that *Dispira* grew very meagrely on such agar media as malt, prune, etc., and produced gemmae by which the fungus was able to remain viable for weeks, in fact even until the agar was almost completely desiccated. Later when it was learned that *D. cornuta* was able to grow and sporulate as a saprophyte on certain media of high protein content as egg (PLATE 41, FIG. 1), swordfish and beef, it was transferred directly to these. Of these media, egg proved to be the most satisfactory both for growth and sporulation and for this reason it was used almost exclusively for the cultivation of this fungus. The egg medium (PLATE 41, FIG. 1) was prepared by beating together the whites and yolks of several raw eggs, then coagulating this mixture in the autoclave. After cooling, the resultant spongy mass was chopped into fine pieces, placed in suitable containers and sterilized.

While conducting these culture experiments it was observed that *Dispira* grew luxuriantly and sporulated abundantly on suitable media between 21° and 27° C., while at the lower temperatures of 8° and 10° C., or at higher temperatures around 35° C., it grew meagrely and failed to sporulate. Likewise it was found that spore germination occurred at the temperature range suitable for growth. Between 21° and 27° C., eighty-two per cent of the spores in hanging drops of 1.5 per cent proteose-peptone solution produced germ tubes 7–13 microns in length within five hours, while at 8° and 10° C. only four per cent of the spores produced germ tubes over a period of three days, and at 35° C. two per cent of the spores germinated and produced only short, abortive germ tubes.

In mounting the fungus for microscopical examination, Amann's lactophenol (**6**), with either acid fuchsin or cotton blue incorporated as stains, was found to be very useful because it did not cause plasmolysis of the fungus nor the retention of air bubbles around the parts to be examined. When the fungus was placed in water, it soon became flaccid and retained enough air bubbles to obscure the parts to be examined, although great care was exercised in the preparation of these mounts. The fertile hyphae of this fungus are covered with a substance, probably fatty in

nature, because they become black when exposed to solutions containing osmic acid. Perhaps for this reason they wet with difficulty.

RESULTS OF CULTURE EXPERIMENTS

Once the fungus was isolated as outlined above, its cultivation was attempted on various types of artificial media to determine the nutrients essential for the growth of this organism. The media used, their composition and preparation, the extent of the vegetative growth and of the sporulation of *D. cornuta* on these media are presented in the following table.

The extent of growth and of sporulation of *D. cornuta* has been expressed by such terms as "poor," "meagre," "fair," etc. Although it is realized that these terms fail to express the exact degree of development, still they are sufficient to convey to the reader some idea of the character of growth of this fungus upon the various media. An examination of this table shows the following points of interest.

(1) *Dispira cornuta* which was formerly considered to be an obligate parasite on members of the Mucorales, can be cultivated on certain artificial media derived from animal products. The media found suitable for the growth and sporulation of this fungus are egg in various forms, beef, swordfish, and to a certain extent rat dung.

(2) Although this fungus is a plant parasite, it will neither grow nor sporulate on such vegetable products as potato, bean pods, meats of Brazil nuts, cornmeal and oatmeal, which with the exception of Brazil nuts, are used commonly for the cultivation of plant parasites. In contrast to these results, Sawyer (**8**) found that *Entomophthora sphaerosperma* Fres. and *Empusa* sp., parasites on insects, grew on such common vegetable substances as beans, peas, potato and oatmeal besides on various animal products as egg yolk, meat, and different kinds of fish. Similarly, Lefebvre (**7**) reported the successful culture of *Beauveria Bassiana* (Bals.) Vuill. and *B. globulifera* (Speg.) Piccard, parasites on corn borer larvae, upon cornmeal, oatmeal and potato.

(3) *D. cornuta* can be cultured in such liquid media as aqueous solutions of peptone, proteose-peptone, nutrient broth and "Bacto-beef" infusion but will not sporulate in them. More-

over, when agar is added to these solutions, or even when solid rat dung is covered completely with agar, the fungus grows meagrely. Similarly Sawyer (**8**) observed that agar inhibited the growth of *Entomophthora sphaerosperma* and *Empusa* sp. when added to liquid media in which the fungi would normally grow. Agar, probably because of its physical nature retards or inhibits the growth of certain fungi.

(4) In liquid media containing only maltose, sucrose, lactose or dextrose, *Dispira* will not grow; therefore, it seems that sugars are not a source of food for this fungus. Furthermore, sugars are not required by this organism since it grows in media either lacking or containing minute traces of these substances.

(5) Apparently this fungus does not require fats for its metabolism, since it grew in media such as solutions of derived proteins (**2**) which at the most contain only very minute quantities of these substances, and it is unable to grow on cod liver oil or Mazola oil.

(6) Furthermore *Dispira* will not grow in liquid media containing complex nitrogenous compounds only, such as solutions of urea, asparagin and egg albumin. Obviously, it is necessary that such derived proteins as proteoses, peptone, peptids or polypeptids are in the medium as a source of food.

After being cultured for more than three years on artificial media *Dispira* is still able to parasitize the same members of the Mucorales as when it was first isolated. In contrast, certain parasites of the higher plants have been found to lose their pathogenicity after they have been cultivated in artificial culture for some time. Eddins (**3**), for example, observed that four multisporidial cultures of *Ustilago Zeae* (Beckm.) Ung. were unable to produce smut galls on corn after six subsequent transfers, while Edgerton et al (**4**) found that certain species of *Pythium*, after being cultivated for two years, could not infect their original hosts.

SUMMARY

(1) *Dispira cornuta* was isolated and cultivated on certan artificial media. The methods of isolation and culture are given, also the extent of growth and of sporulation on various media is tabulated.

TABLE I

GROWTH OF DISPIRA CORNUTA IN ARTIFICIAL CULTURE

Media used	Vegetative growth[a]	Conidial formation[a]	Media used	Vegetative growth[a]	Conidial formation[a]
Agar media			*Liquid media*		
"Difco" bean pod agar	x	–	Cod liver oil. Autoclaved	–	–
"Difco" nutrient agar	x	–	"Mazola" oil. Autoclaved	–	–
"Difco" nutrient agar plus horse dung	x	–	Dextrin, 1% aqueous solution	–	–
"Difco" nutrient agar plus rat dung	x	–	Lactose, 1% aqueous solution	–	–
"Difco" Sabouraud's dextrose agar	x	–	Sucrose, 1% aqueous solution	–	–
"Sabouraud's conservation" agar ("Difco" proteose peptone 1 part, agar 2 parts)	x	–	Maltose, 1% aqueous solution	–	–
Malt agar (Synthetic)[d]	xx	x	Dextrose, 1% aqueous solution	–	–
Malt extract agar (3% malt extract)	x	–	Urea, 1% aqueous solution	–	–
"Difco" cornmeal agar	x	–	Asparagin, 1% aqueous solution	–	–
"Difco" wort agar	x	–	"Difco" proteose-peptone, 1.5% aqueous solution	xxx	–
Oatmeal agar	x	–	"Difco" proteose-peptone, 5.0% aqueous solution	xxxx	–
Oatmeal agar plus horse dung	x	–	"Difco" peptone, 1% aqueous solution	xxx	–
Potato agar	x	–	Nutrient broth		
Potato-rat dung agar	x	–	10 gms. of peptone to 1000 cc. of hot but not		
Potato-dextrose agar	x	–	boiling water. To this were added 4 gms. of		
"Difco" prune agar	x	–	beef extract	xxxxx	–
"Difco" prune agar plus horse dung	–	–	Decoction of *Sporodinia* mycelium	–	–
Scales' whole egg agar[c]	xx	–	"Difco" bacto-beef solution 5% aqueous solution	xxxxx	–
			Richards' solution[c]	–	–

Media used	Vegetative growth[a]	Conidial formation[a]	Media used	Vegetative growth[a]	Conidial formation[a]
Plant products—No agar added			*Animal products—No agar added*		
Rolled oats. Autoclaved	–	–	Egg (See Methods and Materials)	xxxxx	xxxxx
Potato disks. Autoclaved	–	–	Egg yolk. Autoclaved	xxxx	xxxx
Potato disks, raw	–	–	Egg yolk, raw	xxxx	xxxx
Cornmeal (yellow). Autoclaved	x	–	Egg whites, raw	–	–
Meats of Brazil nuts.[b] (*Bertholletia excelsa* Humb. & Boupl.)	–	–	Egg whites. Autoclaved	–	–
Mycelium[b] of *Mucor sp.* Autoclaved	–	–	Beef scraps. Autoclaved[b]	xxx	xx
Beans pods.[b] Autoclaved	–	–	Swordfish.[b] (*Xiphias gladius L.*)	xxx	xxx
Mycelium of *Sporodinia*.[b] Autoclaved	–	–	Herring.[b] ((*Pomolobus pseudoharengus* Wilson)	–	–
			Horse dung.[b] Autoclaved	–	–
			Rat dung.[b] Autoclaved	xx	xx

[a] Explanation of symbols: No growth = –; Trace = x; Meagre = xx; Fair = xxx; Good = xxxx; Luxuriant = xxxxx.

[b] Indicates that the material was placed on moistened absorbent cotton.

[c] Richards' Solution consisted of 10 grams of KNO_3, 5 grams of KH_2PO_4, 2.5 grams of $MgSO_4$, 20 mg. of $FeCl_3$, 50 grams of sucrose and 1000 cc. of distilled water.

[d] Levine & Schoenlein. A Compilation of Culture Media. For the Cultivation of Micro-organisms. William & Wilkins, Baltimore, Md. 1930. Formula No. 1579.

[e] Ibid. Formula No. 1957.

(2) Nutrient agar media were found to be unsuitable for the cultivation of *D. cornuta;* but on solid media as swordfish, meat and egg yolk, which are rich in certain proteins, it grows and sporulates satisfactorily.

(3) Liquid media containing only proteins, supported vegetative growth but not sporulation.

(4) Carbohydrates and fats either in liquid or solid media were unsuitable for the growth of the fungus.

(5) The optimum temperature for growth and sporulation and also for the germination of the spores is between 21° and 27° C., the minimum is near 8° C.; and the maximum temperature is about 35° C.

(6) *D. cornuta,* although it has been cultured for several years on various artificial media is still able to parasitize the same hosts as when first isolated.

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EXPLANATION OF PLATE 41

(1) *D. cornuta* growing as a saprophyte and sporulating on a medium consisting of the white and yolk of egg; (2) *D. cornuta* growing as a parasite on *Lymania* sp. The Dispira can be distinguished easily from its host by the chalky appearance of the sporophores and their dichotomous method of branching. 25 days old. × 1.6 approx.; (3) *D. cornuta* on *Mucor* sp. which is growing on potato-rat dung agar. Note the dichotomous branching of the sporophores of *D. cornuta*. × 12 approx.; (4) *D. cornuta* growing on *Pilobolus* sp. Note the manner of branching of the fertile hyphae and the distribution of the fertile heads on the foregoing branches. × 40 approx.

NORTH AMERICAN HYPHOMYCETES. I. TWO NEW HELICOSPOREAE AND THE NEW GENERA HAPLOCHALARA AND PASPALOMYCES [1]

DAVID H. LINDER

(WITH PLATE 42)

While going over collections made during the past several years, the writer discovered among his material several forms which do not agree with any of the species, and in some instances genera, that have as yet been published. Of these novelties, three will be described from material in the writer's herbarium, and one from the collection of Helicosporeae gathered by the late Professor Thaxter.

The first species is a beautiful one which superficially resembles *Helicoon fuscosporum* Linder,[2] but may readily be distinguished from it by the longer and more flexuous conidiophores, the conspicuous sporogenous teeth, and the stouter and less frequently coiled conidial filaments. Because of the conspicuous characters that separate it from other members of the genus, this species is described as new and is dedicated to the memory of the late Professor Roland Thaxter in recognition of his intense interest in the helicosporous Fungi Imperfecti.

Helicoon Thaxteri sp. nov. (PLATE 42, FIGS. 1–3.)

Coloniae effusae "Buffy Citrine" vel "Brownish Olive";[3] conidiophoris 90–230 × 2.7–4.5 μ, primum rectis deinde elongatis flexuosisque, parce ramosis, ramis elongatis et raro anastomosis, pellucidis, dilute fuscis vel ad cellulas extremas hyalinis, multiseptatis, septis atro-fuscis; dentibus sporigeris 2.5–3.5 × 1.–2.5 μ, pleurogenis, hyalinis vel subhyalinis; conidia

[1] Contribution from the Cryptogamic Laboratory of Harvard University. No. 117.

[2] Linder, D. H. A monograph of the helicosporous Fungi Imperfecti. Ann. Missouri Bot. Gard. **16**: 227–388, *pl. 12–13.* 1929.

[3] Ridgway, R. Color standards and nomenclature, Washington, D. C., 1912, employed when color names are capitalized and placed within quotation marks.

primum hyalinis vel subhyalinis deinde fuscis vel brunneis, filis in helices elongato-ellipsoideas, (3-)–4–(5-) seriatas convolutis, ad septa atro-fusca constrictis, (5.4)–9 μ crassitudine, ad extrema exteriora rotundatis, ad bases fastigatis subhyalinisque; conidiis totis (23.5)–30.5–36–(41.5) $\times$ (14.4)–19.8–(22) μ.

Colonies effuse "Buffy Citrine" to deep "Brownish Olive"; conidiophores 90–230 $\times$ 2.7–4.5 μ, at first simple and erect or suberect, later becoming elongate and flexuous, sparsely branched below, the branches elongate and occasionally anastomosing, pellucid, dilute fuscous to hyaline or subhyaline at the terminal cells, frequently septate, the septa dark fuscous; sporogenous teeth 2.5–3.5 $\times$ 1.5–2.5 μ, pleurogenous and scattered along the upper half of the conidiophore, stout, hyaline to subhyaline; conidia at first dilute fuscous becoming fuscous or brown with age, the filament 5.4–9 μ thick, constricted at the deep fuscous septa and coiled in three planes to form a (3-)–4–(5-) seriate elongate-ellipsoidal spore body, the apical cell abruptly rounded, the basal cell tapering to 1.5–2μ at the point of attachment and hyaline to subhyaline; the coiled conidia (23.5)–30.5–36–(41.5) $\times$ (14.4)–19.8–(22) μ.

On decaying wood, Cocoanut Grove, Florida, R. Thaxter, TYPE.

The second fungus was collected in 1931 by the writer while he was collecting in Missouri. This, a species of *Helicoma* growing in association with *Xenosporella larvalis* (Morg.) Linder, because of the shape, size, and number of septations of the conidia, closely resembles *Helicoma Curtisii* Berk. A careful comparison of the material with that which has been considered to be typical of *H. Curtisii* shows that there are certain points of difference. In the first place, the sterile repent mycelium as it grows over the surface of the substratum and matures, becomes, by the inflation of the cells between the septa, toruloid in aspect. Such bullate cells of the sterile mycelium are absent in *H. Curtisii*. In contrast to the latter species, the erect hyaline or subhyaline conidiophores when only at the 1-celled stage may bear conidia. Subsequently these immature conidiophores develop into the multiseptate and dark spore bearing structures. A more obvious difference between this species and *H. Curtisii*, is the presence of a large number of conidiophores, the terminal or subterminal cells of which are strikingly inflated. It was at first thought that these inflated cells, and the inflated cells of the sterile mycelium, were caused by some internal parasite but a study of a number of preparations

failed to reveal any structure that would indicate the presence of such a disturbing factor. Because of the differences between this form and its nearest ally, if such a term may be used in speaking of form-species, this species is deemed worthy of recognition and for it the binomial *Helicoma inflatum* is proposed.

Helicoma inflatum sp. nov. (PLATE 42, FIGS. 10–11.)

Coloniae effusae, atro-brunneae vel atro-viridifuscae; myceliis sterilibus repentibus, ramosis, septatis, cellulis myceliorum superficialium saepissime forte inflatis; conidiophoris 18–119 × 5–7 μ, primum hyalinis deinde fuscis vel sursum hyalinis, simplicibus, raro breve-ramosis, cellulis terminalibus vel subterminalibus denticulatis, saepe forte inflatis tum 8.5–12 μ crassitudine, vel cellulis terminalibus pluries rotundato-fastigatis et non inflatis; dentibus sporigeris parvis, 1 × 1 μ, hyalinis, persistentibus; conidiis hyalinis, acrogenis vel rarius pleurogenis, filis (4)–5–6–(7) μ diam., in 1¼–1¾ spiras convolutis, (3-)–4–7-(8-) septatis, septis hyalinis, cellulis extremis abrupte rotundatis, cellulis basilaris rotundato-fastigatis apiculatisque; spiris 13.5–18 μ diametro.

Colonies effuse, velvety, dark brown to very dark olive-brown; sterile mycelium repent, branched septate, and when growing on the surface of the substratum conspicuously inflated between the septa; young conidiophores when one- or two-celled hyaline to dilute fuscous, the older ones fuscous below but becoming hyaline at the apical cells, simple or very rarely short-branched, the terminal or subterminal cells denticulate, frequently inflated and 8.5–12 μ thick at the widest part, or else not inflated and then rounded tapering at the apices, 18–119 × 5–7 μ; sporogenous teeth hyaline, small, 1 × 1 μ, persistent; conidia hyaline, acrogenous or rarely pleurogenous, 1¼–1¾ times coiled, (3)–4–7–(8-) times septate, the septa hyaline; the filaments (4)–5–6–(7) μ in diameter with abruptly rounded terminal cells and rounded-tapering basal cells, truncate at the point of attachment; the coiled conidia 13.5–18 μ in diameter.

On the inner side of bark on a prostrate oak log, near Valley Park, Missouri, April 5, 1931, Linder, TYPE.

The third fungus to be described belongs in the Dematiaceae-Didymosporeae near the genus *Beltramia*. It is so placed because in addition to the conidiophores it also produces erect sterile hyphae. It is these long, slender, flexuous, and deep fuscous sterile hyphae which form the loose dark cottony layer that makes the species so striking in spite of the fact that they extend far beyond the conidiophores and partially conceal the large number of yellow conidia. If the mycelium from which the sterile bristles

have arisen is traced in the superficial layers of the substratum, it will be found that it gives rise also to one or more conidiophores, each of which is composed of a slender rather elongate non-septate or few-septate stipe which, unlike that of *Beltramia*, is terminated by a succession of short, subhyaline or hyaline spore bearing cells. Each cell is provided with an apiculus or sporogenous tooth which projects at an angle and bears a single fragile chain of usually two elongate-ellipsoid, uniseptate spores. After the first spore or spore chain is produced, the cell continues its growth and elongates to form a second cell, but since the first spore was formed apically, the elongation is initiated at a point a little below the tip, thus forcing the sporogeous tooth to one side and making the original spore-bearing cells somewhat elbowed (PLATE 42, FIG. 4) so that they resemble somewhat the oögonia and antheridia produced seriately by *Monoblepharis* of the Phycomycetes. The entire conidiophore when nearly devoid of its numerous conidia reminds one of the simple inflorescence found in certain species of the gramineous genus *Paspalum*. Because of this resemblance, and also because of the distinctive characters of the fungus, it is placed in the new genus *Paspalomyces* and designated as *Paspalomyces aureus*.

Paspalomyces gen. nov.

Fungus myceliis repentibus, fuscis vel dilute fuscis, septatis ramosisque, hyphas steriles et conidiophora gerentibus; hyphis sterilibus longis, tenuibus, rectis vel adscendentibus flexuosisque, atro-fuscis; conidiophoris subhyalinis vel subfuscis, sursum hyalinis, cellis stipitis paucis, longis, cellulis sporigeris brevibus, paucis vel pluribus, lateraliter apiculatis et saepe geniculatis; conidiis ellipsoideis, uniseptatis, catenulatis.

Vegetative mycelium fuscous to light fuscous, septate, branched, producing both sterile hyphae and conidiophores; sterile hyphae long, slender, erect or ascending, and deep fuscous; conidiophores subhyaline to dilute fuscous with elongate basal cells surmounted by numerous short, acropetalously formed conidium bearing cells; conidia ellipsoid, light colored and uniseptate, and in chains.

Paspalomyces aureus sp. nov. (PLATE 42, FIGS. 4–6.)

Coloniae "Olive Citrine" vel "Dull Citrine," stratum gossypinum hypharum elongatium gracilium flexuosarum formatum; hyphis sterilibus 250–400 × 2.5–3.6 μ, sursum fastigatis ubi 1 μ diam.; conidiophoris 36–150 × 1.8–2 μ (supra 3.6 μ diam.), dilute fuscis vel subhyalinis, pellucidis, simplicibus, rectis, infra pauce septatis (1–3), supra frequente septatis, cellulas hyalinas, 3.6 μ diam., unilateraliter et leniter bullatas formantibus; conidiis 9–11 × 3.6–

4.5 μ, catenulatis, catenulis fragilibus plerumque sporarum duarum, citrinis vel subvitro hyalinis, elongato-ellipsoideis, uniseptatis et saepe ad septa leniter constrictis.

Colonies forming an " Olive Citrine " to " Dull Citrine " cottony layer of slender elongate flexuous hyphae; sterile hyphae 250–400 $\times$ 2.5–3.6 μ, deep fuscous, simple, elongate, slender and flexuous, sparsely septate, tapering upward to 1 μ; conidiophores 36–150 $\times$ 1.8–2 μ, light fuscous to subhyaline, pellucid, simple, erect, few septate (1–3) below, closely septate above to form sporogenous cells that are 3.6 μ in diameter and mostly bulging at the base of the oblique sporogenous teeth; conidia 9–11 $\times$ 3.6–4.5 μ, in fragile chains that are usually composed of two spores, yellow in mass, hyaline under the microscope, elongate-ellipsoid, 1-septate, frequently slightly constricted at the septa.

On maple bark, Canton, Massachusetts, August 1925, Linder, *1204*, TYPE; on maple bark, Milton, Massachusetts, September 24, 1925, Linder, *1273*.

The last fungus to be described was gathered in the early spring of 1928 near Louisville, Kentucky. It belongs in the tribe Chalariae Sacc. of the Dematiaceae-Amerosporeae in which Lindau [4] places those species which produce conidia endogenously and in chains. As represented by *Thielaviopsis* and *Chalara*, among other genera, the species all produce their spores in chains and at least two or three spores are enclosed within the terminal cell of the conidiophore, although they may be forced out through the open apex of the cell when additional spores are formed. A modification of this method of spore production is shown by the fungus under discussion since the process is intermediate between the truly endogenous and exogenous types of spore formation. Although spore formation is initiated internally, by the time the spore has attained about half of its eventual dimensions, the upper part protrudes beyond the limits of the thick colored wall of the conidiophore (PLATE 42, FIG. 7), but it still remains within the hyaline, almost invisible, theca or outer layer. This hyaline outer layer is eventually ruptured by the enlarging spore and remains just below the apex of the conidiophore as an irregular transparent collar. Occasionally the collar persists and others are added by the successive formation of conidia. It is evident that sporulation is confined to the apical cells of the simple erect conidiophores, yet these

[4] Lindau, G., in Rab. Krypt.-Fl. 1[8]: 747–760. 1906.

cells do not appear capable of unlimited production since conidiophores have been noted which have continued growth after a period of sporulation and have formed one or more sporogenous cells, indicated by local inflations of the fertile hyphae. Since the semi-endogenous method of spore production separates this form from all other members of the *Chalariae,* and in fact from other described genera of the Dematiaceae, it is placed in the new genus *Haplochalara.*

Haplochalara gen. nov.

Fungus myceliis sterilibus immersis, hyalinis vel subhyalinis, septatis; conidiophoris fuscis, rectis, simplicibus, septatis; conidiis hyalinis vel fuscis, primus internis deinde externis et catenulatis.

Sterile mycelium growing within the substratum, septate, hyaline or subhyaline; conidiophores fuscous, erect, simple; conidia 1-celled, hyaline or becoming fuscous with age, at first internal but later external and in chains.

Haplochalara angulospora sp. nov. (PLATE 42, FIGS. 7–9.)

Coloniae effusae atro-brunneae, strata hirsutula formantes; myceliis sterilibus immersis, septatis, hyalinis vel subhyalinis; conidiophoris 70–200 × 4.5–5.5 μ, fuscis vel atrofuscis, simplicibus, septatis, cellulis aliquis infra vel supra inflatis; conidiis 6.5–7.5 × 5–7 μ, rotundato-obconicis, primum imternis deinde externis, catenulatis fuscescentibusque.

Colonies effuse, somewhat velvety, dark brown to almost black; sterile mycelium growing within the substratum, hyaline to subhyaline, septate, and giving rise to the dark brown or brown, simple, erect, septate conidiophores measuring 70–200 × 4.5–5.5 μ with some cells inflated either at the upper or lower end; conidia, 6.5–7.5 × 5–7 μ, at first internal and hyaline but later become external, light fuscous, rounded-obconic, and catenulate.

On decaying beech log, near Louisville, Kentucky, March 23, 1928, Linder, TYPE.

As shown in plate 42, figure 8, an *Acrotheca*-like form was found growing with the species just described, and should be mentioned since if it should subsequently be shown that it is an exogenous phase, then *Haplochalara* would have to be classified along with the genera *Thielaviopsis* and *Chalaropsis* which also produce an exogenous spore-form. Unfortunately in this instance the conidiophores of both forms arise from mycelia that are imbedded in the woody substratum and since they are both light

colored it is difficult to determine with any degree of certainty whether the association is accidental or not. The occurrence of the exogenous form is by no means constant, nor can its appearance be correlated with the age of the colonies. In the middle and presumably more mature portions of the larger colonies the *Acrotheca*-like form may be absent or it may be present and even scandent on the conidiophores of *Haplochalara*. Although the question of the relation of the two forms is left open, it seems desirable to list the more important characters of this second form as follows: conidiophores simple from repent or scandent sterile mycelium, subhyaline, 10–18 × 3–3.5 μ; the conidia fusoid, 2- to 3-septate, hyaline, 11–13.5 × 2 μ.

The types of all specimens described in this paper have been deposited in the Farlow Herbarium of Harvard University.

EXPLANATION OF PLATE 42

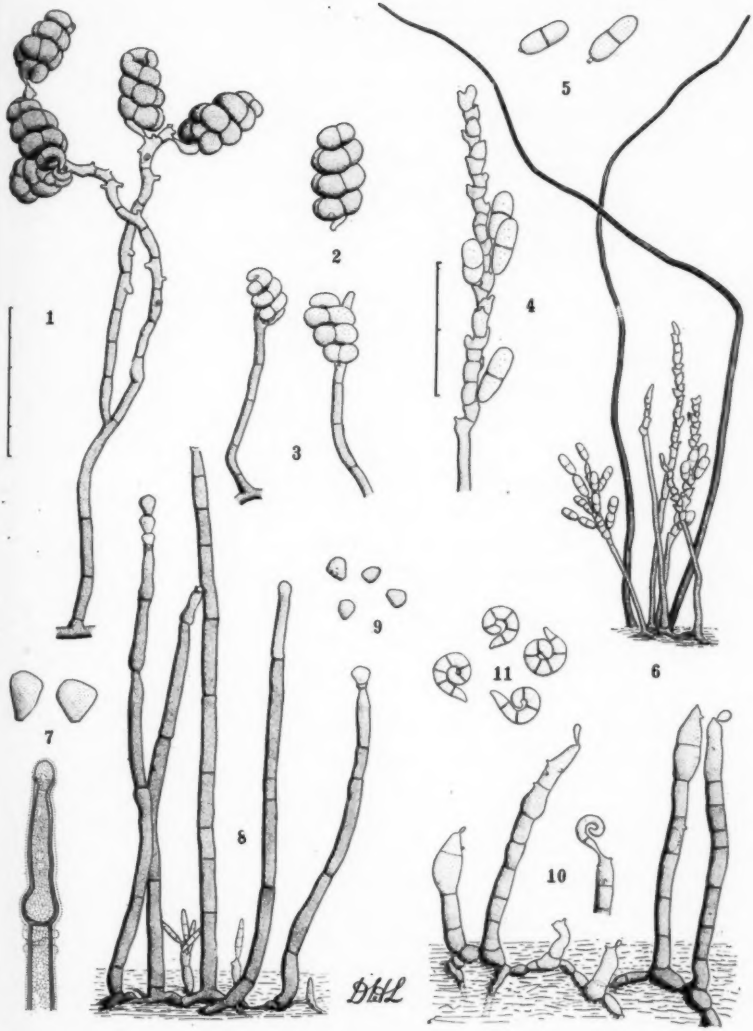
All drawings were made with the aid of a camera lucida from material mounted in lactophenol-cotton blue. Each division of the scale represents 10 μ.

Helicoon Thaxteri, figures 1–3. 1, A well developed conidiophore showing the characteristic loose branching and the numerous stout sporogenous teeth. × 500; 2, A single mature conidium to show the 4-seriate helix, and the tapering subhyaline basal cell. × 500; 3, Young erect conidiophores bearing the immature and subhyaline conidia. × 500.

Paspalomyces aureus, figures 4–6. 4–5, Terminal portion of a conidiophore (fig. 4) to show the arrangement of the fertile cells and the spore-bearing teeth. The conidia (fig. 5) are frequently apiculate from the remnants of the sporogenous teeth. × 1125; 6, A characteristic group of conidiophores with the accompanying long flexuous sterile hyphae. × 500.

Haplochalara angulospora, figures 7–9; 7, Conidium and the tip of a conidiophore to illustrate the semi-endogenous type of spore formation found in this species. The hyaline theca that surrounds the spore and conidiophore should be observed. × 1125; 8, A group of conidiophores showing various stages in spore production, also the swellings of the conidiophore which mark the points where sporulation has already taken place. At the base of the conidiophores may also be seen the *Acrotheca*-like form that is frequently present, but probably is not a definite phase in the life-history of *Haplochalara*. × 500; 9, Several conidia to indicate variation in size and shape. × 500.

Helicoma inflatum, figures 10–11. Conidia and conidiophores. In figure 10 are shown the bullate basal cells and the inflated terminal and subterminal cells of the conidiophores. The two erect 1-celled branches are immature conidiophores. × 500.



HYPHOMYCETES

NEW AND RARE NORTH AND SOUTH AMERICAN USTILAGINALES[1]

GEORGE L. ZUNDEL

Through the courtesy of Mr. J. A. Stevenson, U. S. Department of Agriculture, the author received for study, verification, and identification duplicate specimens of the smut collections of the late E. Bethel (Reliquiae Bethelianae), collected in western United States, and also collections of unidentified smuts made in Brazil by Agnes Chase during 1929 and 1930. As a result of this study, five rare species and eight new species of smuts are considered worthy of being reported in this paper.

The Latin diagnoses of the new species were made by Dr. Robert E. Dengler, Professor of Classical Languages, the Pennsylvania State College. Dr. Dengler's interest in and connections with botany make him unusually well qualified for this type of work. His interest and willingness to coöperate are hereby acknowledged.

1. USTILAGO PASPALI-DILATATI P. Henn. in Brefeld. Unters. **12**: 122. 1895.

On *Paspalum Urvillii* Steud., red clay, altitude 640–660 meters, Viçosa, Minas Geraes, Brazil, coll. Agnes Chase, Nov. 15–17, 1929. Plants of Brazil No. *10183½*. This determination is only provisional until type material is available for comparison.

This smut has not been reported outside of Brazil. It was first collected on *Paspalum dilatalum* at Poiret, pr. Blumenau, Brazil.

2. USTILAGO SCHRÖTERIANA P. Henn. Hedwigia **35**: 215. 1896.

On *Paspalum conspersum* Schrad., on dry black mud near streamlet, altitude 600–625 meters, São Miguel (northeast of Formiga), Minas Geraes, Brazil, coll. Agnes Chase, Jan. 9, 1930. Plants of Brazil No. *10541½*.

On *Paspalum paniculatum* L., waste ground, altitude 600–625

[1] Contribution from the Botany Department, the Pennsylvania State College, No. 81.

meters, São Miguel (northeast of Formiga), Minas Geraes, Brazil, coll. Agnes Chase, Jan. 6, 1930. Plants of Brazil No. *10571*.

The type locality of this smut is St. Catharina, Brazil. It has also been collected in Porto Rico. Type material was available for comparison with the collections above reported.

3. **Ustilago Goyazana** Zundel, sp. nov.

Sori in the ovaries completely destroying the infloresence, surrounded by a delicate membrane, upon rupturing revealing a brown spore mass; spore globose or sub-globose, olive-brown, apparently smooth, but under oil immersion minutely echinulate, 3.5–5 μ diam.

On *Mesosetum loliiforme* (Hochst.) Chase, Goyandera, Goyaz, Brazil. Collected by Agnes Chase, March 26–27, 1930. Plants of Brazil No. *11555*.

Soris in ovariis totam inflorescentiam destruentibus; membrana delicata ambiente; soris ruptis massa brunnea sporarum detecta; sporis atro-olivaceis, glabris at minute echinulatis, 3.5–5 μ diam.

Hab. in inflorescentia *Mesoseti loliformis* (Hochst), Chase, Goyandera, Goyaz, Respub. Brasil.; coll. Agnes Chase 26–27 Mart. 1930. Plants of Brazil No. *11555*.

4. **Ustilago Bethelii** Zundel, sp. nov.

Sori in the leaves as striae ranging in length from a few cm. to nearly the entire length of the leaf, finally causing the leaves to become shredded; at first covered with a white membrane, but when ruptured disclosing a black spore mass; spores spherical to sub-spherical to ovoid, regular, dark reddish-brown, apparently smooth, but under oil immersion lens inconspicuously echinulate, 14–17 μ in diameter.

On *Muhlenbergia montana* (Nutt.) Hitch., Idaho Springs, Colorado. Collected by E. Bethel, Sept. 3, 1923.

Soris in foliis, in series longas a paucis centimetris usque ad folii longitudinem dispositis, foliis denique scissis; membrana soros primo celante postea rupta sporarum massam atram detegente; sporis globosis vel subglobosis vel ovoideis, regularibus, obscure rubro-brunneis, glabris at minute subechinulatis, 14–17 μ diam.

Hab. in foliis *Muhlenbergiae montanae* (Nutt.) Hitch., Idaho Springs, Colorado, in America septent.; coll. E. Bethel 3 Sept. 1923.

Four species of smuts have previously been described on *Muhlenbergia* sp. as follows:

(1) *Ustilago mexicana* Ellis & Ev. has the sori in individual

spikelets of the inflorescence and smooth spores 5.5–8 μ diameter.

(2) *Ustilago Muhlenbergiae* P. Henn. has sori in the abortive inflorescence, with ovoid to spherical and granular echinulate spores 4–6 μ in diameter.

(3) *Sphacelotheca montaniensis* (Ellis & Holw.) Clinton has sori in the inflorescence and echinulate spores 12–15 μ in diameter.

(4) *Tilletia Muhlenbergiae* Clinton has sori in the inflorescence and winged reticulate spores 28–34 μ in diameter.

5. **Ustilago coloradensis** Zundel, sp. nov.

Sori in the leaves and leaf-sheaths, usually forming oblong-cylindric pustules, rounded at the ends, chiefly 1–5 mm. or apparently by terminal coalesence more elongate, at first firmly agglutinated, but eventually the thin membrane ruptures revealing a dusty spore-mass; spores dark reddish-brown, more or less irregularly polyhedral, occasionally oblong or ovoid to subspherical, smooth under oil immersion lens, 11–14 μ in diameter.

On *Muhlenbergia gracillima* Torr. Manitou, Colorado. Collected by E. Bethel, July 4, 1924.

Soris in foliis et vaginis foliorum, plerumque in pustulis oblongo-cylindricis dispositis, terminis rotundis 1–5 mm. vel per fusionem terminalem longioribus; primo firme agglutinatis, postremo, membrana tenui rupta, sporarum massa pulverulenta detecta; sporis obscure rubro-brunneis, plus minus irregulariter polygonis, rarius oblongis vel ovoideis vel sphaeroideis, minute glabris, 11–14 μ diam.

Hab. in foliis vaginisque foliorum *Muhlenbergiae gracillimae* Torr. Manitou, Colorado, in America septent.; coll. E. Bethel, 4 Jul. 1924.

In general appearance this smut resembles *Ustilago Hieronymi* Schröt. on *Bouteloua* spp., but is separated by the smaller, smooth spores.

6. **Ustilago Pseudohieronymi** Zundel, sp. nov.

Sori on the leaves and leaf-sheaths, oblong cylindric, rounded at the ends, 1–3 mm. or by fusion longer. at first covered by a grayish colored membrane which when ruptured discloses a black spore mass; spores subspherical to ovoid, often somewhat angular, irregular, evidently echinulate, blackish-olivaceous, 14–18 μ in diameter.

On *Muhlenbergia squarrosa* (Trin.) Rydb., San Louis Valley, Colorado, collected by E. Bethel, June 27, 1921.

Soris in foliis et vaginis foliorum, oblongo-cylindricis, terminis rotundis, 1–3 mm. vel, post fusionem, longioribus; membrana obscure brunnea primo

tegente, deinde rupta massam atram sporarum detegente; sporis subglobosis vel ovoideis, saepe subangularibus irregularibusque, echinulatis, atro-olivaceis, 14–18 μ diam.

Hab. in foliis et vaginis foliorum *Muhlenbergiae squarrosae* (Trin.) Rydb., San Louis Valley, Colorado, in America septent.; coll. E. Bethel 27 Jun. 1921.

This smut is related to *Ustilago Hieronymi* Schröt. on *Bouteloua* spp. which it resembles very closely but is distinguished by the larger, more prominently echinulate spores.

Ustilago coloradensis Zundel, has smooth spores 11–14 μ diam. which distinguishes it from the above described species.

7. **Ustilago Festucae** Zundel, sp. nov.

Sori in the ovaries at first surrounded by a delicate membrane which when broken discloses a dark brown spore mass, completely destroying the ovary and base of the inner glumes, surrounded by outer glumes which rarely if ever are attacked; spores chiefly subspherical to spherical, light reddish-brown, lighter colored on one side, smooth under oil immersion lens, chiefly 3.5–5 μ, rarely 7 μ in diameter.

On *Festuca Kingii* Cassedy, Fort Collins, Colorado, collected by E. Bethel, July 29, 1905.

Soris in ovariis, membrana delicata primo ambiente, deinde rupta sporarum massam atro-brunneam detegente, ovario atque glumarum interiorum baside prorsus destructis, glumis exterioribus rarius vel numquam affectis; sporis globosis vel subglobosis, dilute rubro-brunneis, ex alia parte dilutioribus, minute glabris, 3.5–5 μ, rarius 7 μ diam.

Hab. in ovariis *Festucae Kingii*, Cassedy, Fort Collins, Colorado, in America septent.; coll. E. Bethel 29 Jul. 1905.

Of the five species of smuts previously described on *Festuca* spp. all of them have larger spores and none have smooth spores.

(1) *Ustilago Mulfordiana* Ellis & Ev. has the sori in the inflorescence often destroying outer basal parts; spores are obscurely verruculose, 12–16 μ diam.

(2) *Ustilago striaeformis* (Westend) Niessl, has the sori as striae on the leaves, rarely attacking the inflorescence, spores are prominently echinulate, 9–14 μ diam.

(3) *Ustilago sphaerocarpa* Sydow, has the sori destroying the ovary, spores are densely verruculose, 15–18 μ diam.

(4) *Tilletia Vulpiae* P. Magn. has the sori destroying and occupying the ovary, spores dark, ellipsoidal, reticulate, 19–17 μ diam.

(5) *Tilletia fusca* has the sori in the ovary, spores reticulated showing as blunt projections on the circumference, 20–25 μ diam.

8. SPHACELOTHECA COLUMELLIFERA (Tul.) Ciferri, Ann. Myc. **26**: 32. 1928.

Ustilago carbo columellifera Tul. Ann. Sci. Nat. III. **7**: 82. 1847.

On *Trachypogon canescens* Nees, campo, altitude 700–725 meters, Casa Branca, São Paulo, Brazil, coll. Agnes Chase, Jan. 16, 1930. Plants of Brazil No. *10598½*.

On *Trachypogon mollis* Nees, open campo summit, altitude 1,100–1,500 meters, Poços de Caldas, Minas Geraes, Brazil, coll. Agnes Chase, Jan. 18–20, 1930. Plants of Brazil No. *10628,* also Buritys, near Rio São Francisco, Minas Geraes, Brazil, coll. Agnes Chase, Jan. 1, 1930. Plants of Brazil No. *10452½*.

On *Trachypogon Montufari* (H.B.K.) Nees, sandy campo, altitude 300–325 meters, Tres Lagoas, Motto Grasso, Brazil, coll. Agnes Chase, Feb. 4–5, 1930. Plants of Brazil No. *10721½*.

This is the first report of this smut from South America. Previously the smut has been reported on *Andropogon* spp. from Algeria, Australia, Madeira Islands, and Tanganyika Territory.

9. **Sphacelotheca Trachypogonis** Zundel, sp. nov.

Sori in the ovaries long linear about 2–3 cm. long, covered by a delicate yellowish membrane which ruptures revealing a dark brown granular spore mass and a well formed columella; spores dark brownish-black, spherical to ovoid, dense, covered with prominent irregular scale-like tubercles, 10–14 μ diam., averaging about 11 μ; sterile cells abundant through the sorus, singly or in groups of two or three, irregular, with a thick hyaline wall and sometimes with yellowish contents.

On *Trachypogon vestitus* Anderss, Campo Grande, Matto Grosso, Brazil. Collected by Agnes Chase, Feb. 7–10, 1930. Plants of Brazil No. *10826*.

Soris in ovariis, linearibus, 2–3 cm. longis, membrana subflava et delicata tectis, massa atro-brunnea granularique sporarum et distincta columella ex rupta membrana apparentibus; sporis obscure atro-brunneis, globosis vel ovoideis, densis, conspicua irregularia squammosaque tubercula porrigentibus, 10–14 μ diam. plerumque 11 μ; cellis sterilibus et per sorum abundantibus, singulis vel binis vel ternis, irregularibus, densis, hyalinis, rarius subflavis.

Hab. in ovariis *Trachypogonis vestiti* Anderss, Campo Grande, in Provinc. Matto Grosso, in Republ. Brasil.; coll. Agnes Chase, 7–10 Febr. 1930. Plants of Brazil No. *10826*.

10. SPHACELOTHECA ANDROPOGONIS (Opiz) Bubak, Naturw. Landes. Böhmen **15**: 25. 1916.

Uredo (*Ustilago*) *Andropogi* Opiz, Naturalien. **1823–24**: 43. 1823.

Sphacelotheca Ischaemi Clinton, Jour. Myc. **8**: 140. 1902.

On *Andropogon goyazensia* Hack., wet vargem, Santo Rita do Araguaya, on Rio Araguaya, Motto Grasso, Brazil, coll. Agnes Chase, April 5–6, 1930. Plants of Brazil No. *11854*.

On *Andropogon Salzmannii* (Trin.) Hack., moist gravelly campo, 4–5 kilometers west of Diamantina, Serra de San Antonio, Minas Geraes, coll. Agnes Chase, Dec. 27–30, 1929. Plants of Brazil No. *10419½*.

This is apparently the first report of this smut from South America.

11. **Sphacelotheca Macrothricis** Zundel, sp. nov.

Sori destroying the floral parts, long linear, 4–5 mm. long, covered with a yellowish-brown membrane which flakes away revealing a dark brown spore mass surrounding a well formed columella; sterile tissue easily breaking up into sterile cells, either singly or in pairs, occasionally in chains, variable in shape but usually irregularly ellipsoidal, hyaline, with walls tinted yellow, 7–14 μ diam.; spores regular, globose to subglobose, olive brown, apparently smooth but under oil immersion abundantly echinulate, 7–14 μ diam.

On *Andropogon macrothrix* Trin., Uberlandia (Uberabinha), Minas Geraes, Brazil. Collected by Agnes Chase, March 15, 1930. Plants of Brazil No. *11253½*.

Soris inflorescentiam destruentibus, linearibus 4–5 mm. longis et membrana flavo-brunnea tectis; membrana rupta massam sporarum atro-brunneam columellam distinctam ambientem detegente; cellis sterilibus, singulis vel binis, rarius catenatis, forma mutabilibus, plerumque irregularibus, ellipsoideis, hyalinis, sub-flavis; 7–14 μ diam.; sporis irregularibus, globosis vel subglobosis, olivo-brunneis, glabris at minute echinulatis, 7–14 μ diam.

Hab. in inflorescentia *Anthropogonis macrothricis*, Uberlandiae (Uberabinha), Provinc. Minas Geraes, Republic. Brasil.; coll. Agnes Chase 15 Mart. 1930. Plants of Brazil No. *11253½*.

This smut in general appearance resembles *Sphacelothecæ occidentalis* (Seym.) Clint. but differs in having more regular, smaller, olive-brown spores.

12. **Sphacelotheca inconspicua** Zundel, sp. nov.

Sori destroying the inflorescence, hidden by the glumes, 2–3 mm. long, covered by a brown delicate membrane which flakes away revealing a brownish spore mass and a well developed columella; sterile cells hyaline, single or in groups about the size of the spores; spores reddish-brown, irregular globose-ellipsoidal, sometimes angled, smooth, 7–10 μ diam.

On *Mesosetum loliiforme* (Hochst.) Chase, vicinity of Goyaz City, Goyaz, Brazil; coll. Agnes Chase, March 20–22, 1930. Plants of Brazil No. *1146*; on *Anoxopus marginatus* (Trin.) Chase, Rio Verde (17° 40′ South 51° West) Goyaz, Brazil, collected by Agnes Chase, April 2, 1930. Plants of Brazil No. *1170½*.

Soris inflorescentiam destruentibus; glumis celantibus; soris 2–3 mm. longis et membrana brunnea delicataque tectis quae in squamas disrupta massam sporarum brunneam et columellam distinctam detegit; cellis sterilibus hyalinis, singulis vel in globo sporarum fere magnitudinem habente distributis; sporis rubro-brunneis, globoso-ellipsoideis, irregularibus, rarius angulatis, glabris, 7–10 μ diam.

Hab. in inflorescentia *Mesoseti loliformis* (Hochst.) Chase prope urbem Goyaz, Provinc. Goyaz, Respub. Brasil.; coll. Agnes Chase 20–22 Mart. 1930. Plants of Brazil No. *1146*; in inflorescentia *Anoxopi marginati* (Trin.) Chase, Rio Verde (17° 40′ austr., 51° occid.) Goyaz, Respub. Brasil.; coll. Agnes Chase 2 Apr. 1930. Plants of Brazil No. *1170½*.

13. UROCYSTIS BORNMULLERI P. Magn. Deuts. Bot. Gessell. **30**: 290–293. 1912.

On *Melica imperfecta* Trin., California, Coll. E. Bethel, 1919 (Reliquiae Bethelianae).

This determination is provisional until the type specimen can be located for comparison. It is at least close to *Urocystis Bornmulleri* P. Magn. having oblong to spherical spore balls 20–42 μ in length, completely surrounded by brownish tinted sterile cells. Spore balls usually contain 3–4 (rarely 2–2) reddish-brown spores measuring 14–18 μ in length.

Urocystis Agropyri (Preuss) Schröt., the only other *Urocystis* reported on *Melica* sp., has oblong to subspherical spore balls 16–32 μ in length that are completely surrounded by hyaline to yellowish sterile cells. Each spore ball consists of 1–2 (rarely 3–4) reddish-brown spores measuring 11–18 μ in length.

BOTANICAL LABORATORY,
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THE HYDNACEAE OF IOWA. I. THE GENERA GRANDINIA AND OXYDONTIA

L. W. MILLER

(WITH PLATE 43)

The fungi here described were all collected in Iowa with the single exception of *Grandinia granulosa* Fries. These have more than local interest since the occurrence of several species has apparently not previously been reported from the United States. The published records of resupinate species of the Hydnaceae in this country, however, are not believed to be a fair index of their frequency or distribution. Many of the little known species are common in Iowa. The vast collections of undetermined material in our larger herbaria indicate the widespread occurrence of these fungi and the need for study of the group.

A key to the genera of the Hydnaceae and a brief taxonomic discussion of *Grandinia* and *Oxydontia* may be found in a previous paper (Mycologia **25**: 286–302. 1933).

GRANDINIA Fries, Epicr. 527. 1838.

Texture variable; warts minute, fragile; hyphae and spores pale or hyaline. This genus differs from *Oxydontia* chiefly in the minute warts.

KEY TO THE SPECIES OF GRANDINIA

1. Subhymenium bearing antler-like, dichotomously branched, thick-walled structures ..... 2. *G. granulosa.*
1. Hyphae not antler-like, relatively thin-walled ..... (2)
   2. Spores minutely but distinctly echinulate ..... 4. *G. farinacea.*
   2. Spores smooth, rarely slightly roughened ..... (3)
3. Basidia with 4–6–8 sterigmata; spores cylindrical or fusiform ..... (4)
3. Basidia with 2–4 sterigmata; spores subspherical or elliptical ..... (5)
   4. Hyphae and basidia guttulate; spores 7–8 × 3–4 μ ... 6. *G. raduloides.*
   4. Hyphae and basidia not guttulate; spores 3–5 × 2–3 μ 5. *G. Brinkmanni.*
5. Fructification separable; teeth hemispherical, collapsing in drying 1. *G. helvetica.*
5. Fructification adnate; teeth hemispherical to short cylindrical, with obtuse crests, not collapsing in drying ..... 3. *G. mutabilis.*

1. GRANDINIA HELVETICA (Pers.) Fries, Hymen. Europ. 627. 1874. (PLATE 43, FIG. 6)

Hydnum helveticum Pers. Myc. Europ. **2**: 184. 1825.
Corticium tomentelloides Höhn. & Litsch. Sitz. Akad. Wiss. Wien **116**: 824. 1907.

Fructification resupinate, effused, thin, separable, floccose-mealy, with a subceraceous hymenial pellicle supported on a loose fibrillose subiculum, stretching in drying and breaking in places, cream color; margin fibrillose, the fibrils branching and running over the substratum; warts hemispherical or dome-shaped, giving to the hymenial surface a colliculose appearance, considerably flattened in drying; hyphae 3.5–7 μ in diameter, not incrusted, thin-walled, with scattered clamp connections, forming rope-like strands, 7–20 μ in diameter, which run over the substratum; basidia 15–30 $\times$ 5–7 μ, short, thick, with 4 sterigmata; spores 3.5–5 μ, spherical or subangular, smooth, hyaline, 1-guttulate.

This species is recognized by its thin, soft, separable membrane, the colliculose hymenium and the slender, branching fibrils. It resembles certain of the thin, membranaceous species of *Corticium*, approaching closely to *Corticium arachnoideum* Berk.

Collected once in Iowa in December, 1931. No report of its occurrence in the United States has come to my attention. However, a specimen of this species labeled *Grandinia membranacea* Ellis & Ev. from Canada, collected by Macoun in 1898, was found in the mycological herbarium of The New York Botanical Garden. Our specimen was carefully compared with specimens determined by Bourdot and by Miss Wakefield and agrees well with the description of the type by Bourdot (1932).

2. GRANDINIA GRANULOSA Fries, Epicr. 527. 1838. (PLATE 43, FIG. 4)

Asterostromella granulosa (Fries) Bourd. & Galz. Hymén. Fr. 396. 1928.

Fructification resupinate, effused, adnate, thin, subceraceous or crustaceous, slightly pruinose, not cracking, warm buff to cinnamon-buff; margin similar; warts hemispherical, crowded; hyphae 3–5 μ in diameter, dichotomously branched and antler-shaped, with thick walls, subhymenial hyphae indistinct; basidia 14–20 $\times$ 4–5 μ; spores 5–6 $\times$ 3.5–4 μ, ellipsoid, smooth, hyaline.

This species is characterized by the numerous thick-walled, antler-shaped hyphal structures. This character is made diagnostic for the genus *Asterostromella* Höhn. & Litsch. Apparently the subhymenial hyphae accompanying the specialized hyphae are thin-walled and very fragile or undergo some transformation, since they always appear indistinct under the microscope.

G. granulosa Fries apparently has never been collected in Iowa but is included here since the state lies within its geographic limits. This description is given also in order to show its relationship to *Grandinia mutabilis* to which the same specific name has occasionally been applied. *G. granulosa* is reported from scattered localities in the eastern United States, but it is doubtful whether in every case the reports refer to the same species as here described. Only a small number of the forty or fifty specimens labeled *G. granulosa* at The New York Botanical Garden were determined correctly.

3. GRANDINIA MUTABILIS (Pers.) Bourd. & Galz. Bull. Soc. Myc. Fr. **30**: 250. 1914. (PLATE 43, FIG. 5)

Hydnum granulosum var. *mutabile* Pers. Myc. Europ. **2**: 184. 1825. *non G. granulosa* Fries.

Odontia olivascens Bres. Fungi Trid. **2**: 36. 1892.

Corticium sulphurellum Höhn. & Litsch. Oest. Cort. 66. 1907.

Odontia mutabilis (Pers.) Bres. Ann. Myc. **9**: 426. 1911.

Grandinia granulosa (Pers.) Bourd. & Maire, Bull. Soc. Myc. Fr. **36**: 74. 1920.

Grandinia Abrotani Vel. Ceské houby 734. 1922. (fide Cejp)

Fructification resupinate, effused, adnate, very thin, ceraceous, not cracking, whitish to tilleul-buff, becoming at times isabelline or greenish in the herbarium; margin similar or pruinose; warts more or less uniformly hemispherical to short cylindrical, very fragile, scattered to crowded, occasionally few or absent; hyphae 3–6 μ, irregularly branched, with occasional clamp connections, not incrusted; basidia 15–20 $\times$ 6–7.5 μ, clavate; spores 4–5.5 $\times$ 3.5–4.5 μ, subspherical, smooth, rarely slightly roughened, apiculate, hyaline.

The thin, ceraceous fructification, the undifferentiated margin and the uniform, obtuse warts, which do not collapse upon drying, are useful characters in the determination of this species.

Thelephora granulosa was described by Persoon in 1801. In

1825 he transferred it to the genus *Hydnum* and recognized several varieties. Form *mutabile,* according to Bourdot and Maire (1920), applied to specimens that have become "jaunissant ou verdissant" in the herbarium. Donk (1930) and Bourdot (1932), however, indicate that *mutabile* and *granulosa* Pers. do not represent the same species. *Grandinia granulosa* Fries is based on a species having a similar fructification but differing sharply in the possession of antler-shaped or dichotomously branched structures in the context and trama. *G. granulosa* (Pers.) Bourd. & Maire and *G. granulosa* Auct. also appear in literature. If Fries's species is to be regarded as a *Grandinia* it seems that the specific name *granulosa* should be retained for his species since he was first to employ it in this genus.

Collected once on deciduous wood near Milford, Iowa, Aug. 8, 1931. No report of the occurrence of this species in North America has come to my attention. A specimen in the Ellis collection in The New York Botanical Garden, labeled *Grandinia membranacea* E. & E., on dead wood, 30/10/98, is *Grandinia mutabilis* as here understood.

4. GRANDINIA FARINACEA (Fries) Bourd. & Galz. Bull. Soc. Myc. Fr. **30**: 253. 1914. (PLATE 43, FIG. 2)

Hydnum farinaceum Pers. ex Fries, Syst. Myc. **1**: 419. 1821.
Hydnum niveum Pers. ex Fries, Syst. Myc. **1**: 419. 1821.
Odontia nivea (Fries) Quél. Fl. Myc. Fr. 435. 1888.
Odontia farinacea (Fries) Bres. Atti Accad. Rovereto III. **3**: 99. 1897. *non* Quélet. 1888.

Resupinate, effused, adnate, very thin, arachnoid under the lens, soft membranaceous, pruinose, white to light buff; margin byssoid or pruinose, white; teeth 2 mm. or less in length, crowded, slender, subulate, fragile, terminating in a bundle of sterile hyphae; trama with calcium oxalate crystals; hyphae 2–4 μ in diameter, fragile, with clamp connections, occasionally swollen at the septa; basidia 12–24 $\times$ 3–5 μ, clavate, with 2–4 sterigmata; spores 3–4 $\times$ 2.5–4 μ, subspherical, minutely echinulate, hyaline.

This species closely resembles *Grandinia Brinkmanni* in color and texture but is readily distinguished by the subspherical echinulate spores. The subulate spines terminated by sterile hyphae and

the powdery masses of conidia which frequently occur on or near the margin of the fructifications offer additional distinctive characters. It may at times be recognized in the field by the latter character. The teeth in Iowa specimens usually do not exceed 1 mm. in length.

Common in Iowa on much decayed coniferous and deciduous wood; collected in all seasons, mostly from April to November. Cejp (1931) first reported it from Iowa. Its occurrence has been reported also from scattered localities in the central and eastern United States. The many specimens under several different names in the Farlow Herbarium, at The New York Botanical Garden and at the University of Iowa indicate that it is fairly common throughout the eastern United States.

5. GRANDINIA BRINKMANNI (Bres.) Bourd. & Galz. Bull. Soc. Myc. Fr. **30**: 252. 1914. (PLATE 43, FIG. 3)

Odontia Brinkmanni Bres. Ann. Myc. **1**: 88. 1903.

Grandinia crustosa Vel. České Houby. 734. 1922. (fide Cejp.)

Fructification resupinate, effused, adnate, very thin, sub-crustaceous, arachnoid under the lens, pruinose, pale smoke gray to nearly white; margin pruinose or minutely fibrillose; teeth 1 mm. or less in length, very fragile, varying from obtuse warts to short, acute teeth, sometimes absent in small areas as in *Corticium;* context with calcium oxalate crystals; hyphae 2–4 μ in diameter, fragile, indistinct; basidia 10–12–24 $\times$ 3–6 μ, clavate or urn-shaped, with 4–6–8 sterigmata; spores 3–5 $\times$ 2–2.5 μ, short cylindrical, slightly curved, smooth, hyaline.

This species is recognized by its thin, whitish, arachnoid subiculum, minute warts and its urn-shaped basidia, often with 6–8 sterigmata. It seems related to certain of the thin forms of *Corticium,* as *C. calceum* Fries and *C. octosporum* Schröt.

This description differs from the original description in the recognition of urn-shaped basidia, a character also observed by Bourdot and Galzin, and in noting that the spores are curved. Bresadola described the basidia as clavate. The basidia in my specimens are at first obovate then develop into the typical basidia which have slightly swollen bases and cylindrical or clavate pro-

longations. Bresadola describes the spores as being cylindrical but does not point out that they are curved. A greater range in spore size is given by Bourdot and Galzin, 3–4.5–6 × 1.5–3 μ. The teeth in my specimens do not exceed 0.5 mm. in length. Bresadola indicates that they may become twice as long. This character, however, seems to be quite variable. Iowa specimens agree well with a specimen from Bresadola's herbarium at The New York Botanical Garden and several specimens from Bourdot at the Farlow Herbarium and in the C. G. Lloyd Mycological Collection.

Fairly common in Iowa. Collected from March to December on very much decayed, coniferous and deciduous wood. No report of its previous occurrence in the United States has come to my attention. However, an undetermined specimen from New Jersey and one from Ohio was found at the New York Botanical Garden.

6. GRANDINIA RADULOIDES (Karst.) Bourd. & Galz. Hymén. Fr. 412. 1928. (PLATE 43, FIG. 1)

Hydnum raduloides Karst., Medd. Soc. Faun. Fl. Fenn. **9**: 110. 1883.

Effused, soft, floccose-pruinose, adherent, white to pale pinkish buff; margin similar; teeth 1.5 mm. or less in length, cylindrical or subulate, rounded at the apex, pruinose, with reddish tint when dry; hyphae 3–5 μ in diameter, thin-walled, guttulate, with clamp connections, more densely compacted in the teeth than in the base of the fructification; context with large, scattered, calcium oxalate crystals; basidia 15–25 × 5–8 μ, urn-shaped, guttulate, basal portion swollen, with 6–8 prominent sterigmata; spores 7–8 × 2.75–3.5 μ, fusiform, smooth, hyaline.

This fungus resembles *Grandinia Brinkmanni* and *Grandinia muscicola* (Pers.) Bourd. & Galz. in the possession of urn-shaped basidia with 6-8 sterigmata. It is quite readily separated from these by its soft, floccose-pruinose texture, guttulate tramal hyphae and basidia, and by its larger spores.

Grandinia raduloides appears to be rare in this country. Bourdot and Galzin report a specimen from the United States received from C. G. Lloyd (no. *1444*). No trace of this species was found in the Lloyd herbarium at Washington, D. C. It was collected

once in 1931 on a fallen and decorticated, frondose limb near Estherville, Iowa, which seems to be the only other record from the United States.

OXYDONTIA Miller, Mycologia **25**: 294. 1933.

Floccose to ceraceous, adnate or separable; teeth or spines relatively large and distinct; hyphae and spores hyaline, pale or bright colored.

KEY TO THE SPECIES OF OXYDONTIA

1. Fructification separable; hymenium light buff when fresh; spores subspherical, about $5 \times 4\ \mu$ ..... 4. *O. macrodon.*
1. Fructification adnate or separable; hymenium darker than light buff; spores elliptical to sub-cylindrical ..... (2)
   2. Fructification strongly adnate; context compact throughout; mycelial strands absent ..... (3)
   2. Fructification separable or with a loose, floccose layer next to the substratum; margin usually with mycelial strands running over the substratum ..... (4)
3. Fructification bright yellow in color, with a strong odor when fresh; spores $5\text{–}6 \times 3\text{–}4.5\ \mu$; restricted to pomaceous hosts ..... 5. *O. setosa.*
3. Fructification mars yellow to mars brown; odor not pronounced; spores $3\text{–}5 \times 1.5\text{–}2.5\ \mu$; on wood of various species ..... 6. *O. stenodon.*
   4. Fructification separable, bright orange in color; spores $3.5\text{–}4.5 \times 2\text{–}2.5\ \mu$ ..... 3. *O. fragilissima.*
   4. Fructification adnexed to the substratum by a loose, floccose layer, white to dark olive buff or avellaneous; spores $7\text{–}12 \times 3.5\text{–}5\ \mu$ .. (5)
5. Hymenium dark olive-buff; hyphae smooth; spores roughened, dark olive-buff ..... 1. *O. alboviride.*
5. Hymenium avellaneous; hyphae often faintly roughened; spores smooth, hyaline ..... 2. *O. Himantia.*

1. OXYDONTIA ALBOVIRIDE (Morg.) Miller, Mycologia **25**: 294. 1933. (PLATE 43, FIG. 12)

Hydnum alboviride Morg. Jour. Cinc. Soc. Nat. Hist. **10**: 12. 1887.

Fructification resupinate, widely effused, 600–800 μ in thickness, consisting of a very loose, floccose, white subiculum which is usually not covered by a hymenium; margin similar or rhizomorphic; spines 2 mm. in length, terete, subulate, pointed, usually sterile at the apex, at first white, then dark olive-buff; hyphae 1.5–5 μ in diameter, loosely interwoven in the subiculum, with numerous clamp connections, smooth; basidia $20\text{–}30 \times 3.5\text{–}5\ \mu$, clavate, with 4 sterigmata; spores $7\text{–}10 \times 3\text{–}4\ \mu$, fusiform, attenuated and slightly curved at one end, roughened, dark olive-buff.

This species is recognized by its loose, floccose subiculum and the dark olive-buff, roughened spores. It has often been confused with *Hydnum Himantia* Schw. from which it may readily be separated by the smooth hyphae and the colored, roughened spores.

Three specimens were collected in Iowa; early April to October. Apparently uncommon. It seems to have been reported only from Ohio. However, specimens of this species collected in Massachusetts, Indiana, Connecticut, New York and Sweden (Romell) were examined at The New York Botanical Garden. The type is probably destroyed. An authentic specimen collected by Morgan in 1888 in the mycological herbarium of the University of Iowa undoubtedly represents the true *Hydnum alboviride* Morg. I have not seen the type or an authentic specimen of *Hydnum byssinum* but strongly suspect it is Schweinitz's name for the same species.

2. OXYDONTIA HIMANTIA (Schw.) Miller, Mycologia **25**: 294. 1933. (PLATE 43, FIG. 11)

Hydnum Himantia Schw. Schr. Nat. Gez. Leipzig **1**: 104. 1822.

Hydnum subfuscum Peck, Ann. Rep. N. Y. State Mus. **40**: 55. 1887.

Odontia himantia (Schw.) Bres. Ann. Myc. **1**: 84. 1903.

Fructification resupinate, widely effused, consisting of a waxy, pelliculose hymenial layer which is avellaneous in color and 50–200 μ in thickness, and a loose, floccose, white layer next to the substratum, 200–1000 μ in thickness, sometimes with large areas of white, cottony mycelium not covered by a hymenium; margin floccose or fibrillose and with white, rhizomorphic strands running over the substratum; spines 6 mm. or less in length, terete, subulate, pointed or obtuse; hyphae 2–4 μ in diameter, faintly roughened, with numerous clamp connections, often swollen at the septa, with scattered masses of crystalline material; basidia 25–40 $\times$ 6–8.5 μ, with 2–4 long sterigmata; spores 10–12 $\times$ 3.5–4.5 μ, cylindrical-ellipsoid, attenuated at one end, smooth, granular or guttulate, hyaline.

The loose, floccose subiculum covered in places by a waxy pelliculose layer, the rhizomorphic strands, the roughened hyphae often swollen at the septa and the large spores are diagnostic characters

for this species. The hymenium of a young fructification may be confined entirely to the spines in which case the white cottony subiculum gives the specimen the aspect of *Oxydontia alboviride*. These two species have been confused in this country. They can be separated readily by the color of the hymenium and the spore and hyphal characters. *Hydnum alboviride* has dark olive-buff, roughened spores and smooth hyphae.

This species occurs on much decayed wood from April to December and apparently is an active wood rotting form. One luxuriant growth was observed covering the lower side of a fallen limb for an estimated distance of 20 feet. It is common in Iowa and apparently widely distributed in the United States. I have examined specimens from eleven states, including several from the west coast. The types of *Hydnum subfuscum* Peck and *Hydnum Himantia* Schw. have been studied.

3. OXYDONTIA FRAGILISSIMA (Berk. & Curt.) Miller, Mycologia **25**: 294. 1933. (PLATE 43, FIG. 8)

Hydnum fragilissimum Berk. & Curt. Grevillea **1**: 100. 1873.
Hydnum ischnodes Berk. Grevillea **1**: 101. 1873. *non* Morgan.
Hydnum chrysocomum Underw. Bull. Torrey Club. **24**: 82. 1897.
Acia chrysocoma (Underw.) Pat. Tax. Hymén. 69. 1900.
Odontia crocea Lloyd, Letter **53**: 11. 1914.

Fructification resupinate, membranaceous, separable, often becoming partially detached in drying, fleshy-ceraceous, ochraceous-salmon; margin white at first then yellowish, fibrillose and with long, orange colored, rhizomorphic strands running loosely over the substratum; teeth 1–4 mm. in length, slender, terete, occasionally confluent, subdistant to crowded, terminated by sterile hyphae; hyphae 4–7 μ in diameter, and thick-walled in the strands and loosely interwoven mycelium next to the substratum, 2–4 μ in diameter and thin-walled in the more compact spines and subhymenial region, septate, without clamp connections; basidia 15–25 $\times$ 4–6 μ, with 2–4 sterigmata; spores 3.5–4.5 $\times$ 2–2.5 μ, ellipsoid, smooth, hyaline.

This species is recognized by its bright orange fructification and the long, mycelial strands of the same color. Its growth is restricted to the lower side of much decayed limbs or bits of wood,

particularly those that are partially submerged in the forest floor. The host tissue immediately above the fructification is often colored red.

I have not seen the type of *H. fragilissimum*. However, I have examined a specimen at The New York Botanical Garden which was taken to Europe and compared with the type by Banker, who has indicated on the label that it is " undoubtedly " the same. The original description of *H. fragilissimum* applies closely to this species. Since the orange usually fades in the herbarium the " white " color mentioned by Berkeley is readily explained. No. *4. Hydnum fragilissimum* Berk. & Curt. in Ellis, North American Fungi, is correctly determined. I have examined the types of *Hydnum ischnodes* Berk. and *Hydnum chrysocomum* Underw. and an authentic specimen of *Odontia crocea* Lloyd. They represent the same species. Lloyd applies Schweinitz's specific name *croceum* to this species merely on the basis of the meager original description. It seems strange that he should come to this conclusion after making an earlier comment (Letter **42**: 4) on the same species, " there is nothing in Schweinitz's short ' description ' to give any clue even to its identity."

Common in Iowa on decayed wood of frondose species. Collected from June to January. Its occurrence in six or seven central and eastern states is recorded.

4. OXYDONTIA MACRODON (Fries) Miller, Mycologia **25**: 294. 1933. (PLATE 43, FIG. 7)

Hydnum macrodon Pers. ex Fries, Syst. Myc. **1**: 415. 1821.
Hydnum fragile Pers. ex Fries, Syst. Myc. **1**: 418. 1821. (*non* Fries. 1874.)
Dryodon mucidum Quél. Fl. Myc. Fr. 438. 1888.
Hydnum separans Peck, Ann. Rep. N. Y. State Mus. **50**: 112. 1897.
?Odontia macrodon (Fries) Bourd. & Galz. Bull. Soc. Myc. Fr. **30**: 264. 1914.

Fructification resupinate, widely effused, soft, subceraceous, farinaceous, membranaceous, separable, often becoming partially detached in drying, light buff when fresh; margin white, similar or byssoid; spines 5–10 mm. or less in length, 0.2–0.3 mm. in

diameter, slender, subulate, terete, sterile at the apices, crowded, often coalescing, scattered near the margin, occasionally curved; hyphae 2–4 μ, distinct, with numerous clamp connections, guttulate; gloeocystidia cylindrical to fusiform, with elongated, subulate and projecting terminations, occasionally obtuse, slightly tortuous, 40–100 $\times$ 5–9 μ; basidia 20–30 $\times$ 4–6 μ, clavate, guttulate, with 2–4 sterigmata; spores 4–6 $\times$ 3–5 μ, subspherical, smooth, hyaline, 1-guttulate.

This species may be recognized by the soft, sub-ceraceous fructification, the long slender spines, the gloeocystidia and the subspherical spores.

Fairly common in Iowa from October to December, on much decayed wood of frondose species. This species may be reported in this country under different names. A number of specimens were observed at The New York Botanical Garden and in other herbaria, which were collected from widely scattered points in the eastern United States and variously determined. The type of *Hydnum separans* Peck seems to possess the characters of a typical specimen of *O. macrodon*. This species has occasionally been referred to *Hydnum mucidum* Pers. The type of the latter species, however, represents an entirely different fungus according to Bresadola (1897), Donk (1931) and Bourdot (1932). *Hydnum fragile* Fries (1874) is applied to a stipitate form.

5. OXYDONTIA SETOSA (Pers.) Miller, Mycologia **25**: 294. 1933. (PLATE 43, FIG. 9)

Hydnum setosum Pers. Myc. Europ. **2**: 213. 1825.
Hydnum luteocarneum Secr. Mycogr. Suisse **2**: 528. 1833.
Hydnum Schiedermayeri Heuf. Oest. Bot. Zeitschr. **20**: 33. 1870.
Dryodon setosum (Pers.) Pat. Hymén. Europ. 146. 1887.
Dryodon luteocarneum (Secr.) Quél. Fl. Myc. Fr. 437. 1888.
Hydnum earleanum Sumst. Torreya **4**: 59. 1904.
Hericium croceum (Schw.) Banker, Mem. Torrey Club **12**: 121. 1906.
Manina Schiedermayeri (Heufl.) Banker, Mycologia **4**: 277. 1912.
Hydnum foetidum Vel. České Houby 744. (fide Cejp). 1922.
Acia setosa (Pers.) Bourd. & Galz. Hymén. Fr. 418. 1928.

Fructification resupinate, becoming widely effused, ceraceous, adnate, thick, sometimes with tuberculous nodules from which curved teeth arise, giving off a strong odor resembling bitter almonds when fresh, primuline yellow, becoming dark with age; margin radially and coarsely fibrillose; spines 4–10 mm. in length, slender, terete, subulate, often swollen and somewhat pubescent at the base, fascicled on the nodules or arising singly, colored similarly to the context or with reddish tips; hyphae 2–5 μ in diameter, thin-walled, with occasional clamp connections, compactly arranged, horizontal next to the substratum; basidia 15–25 $\times$ 4–6 μ, with 4 sterigmata; spores 5–6 $\times$ 3–4.5 μ, obovate, smooth, hyaline, uni-guttulate.

The bright yellow color, the strong pungent odor, the nodulose subiculum, the small obovate, 1-guttulate spores and the largely restricted habitat on pomaceous wood clearly marks this species from other hydnums.

This species is known in Europe as *Acia setosa*. In the United States it commonly goes under the name *Hydnum Schiedermayeri*. I retain the older specific name with some uncertainty since Persoon first described the fructification as " white."

Common on the dead trunks and limbs of *Malus* and *Crataegus* from May to December. Its occurrence is widely reported throughout the central and eastern United States.

6. OXYDONTIA STENODON (Pers.) Miller, Mycologia **25**: 294. 1933. (PLATE 43, FIG. 10)

Hydnum stenodon Pers. Myc. Europ. **2**: 188. 1825.

Odontia stenodon (Pers.) Bres. Atti Accad. Rovereto III. **3**: 96. 1897.

Acia stenodon (Pers.) Bourd. & Galz. Bull. Soc. Myc. Fr. **30**: 256. 1914.

Hydnum mucidum Vel. České Houby 744. (fide Cejp.) 1922.

Fructification resupinate, effused, fleshy-ceraceous, adherent, mars yellow in younger portions to mars brown in older; margin lighter in color; spines 1–2 mm. or less in length, slender, tapering, mostly entire, sometimes fimbriate, crowded and more or less coalescing at the base, sterile at the apex, mars brown; hyphae 2–3 μ in diameter, thin-walled, somewhat coalesced; basidia 10–15 $\times$ 3–4 μ, clavate; spores 3–4.5 $\times$ 1.5–2.5 μ, elliptical, depressed on one side, smooth, hyaline.

The Iowa specimen resembles *Odontia uda* and *O. fuscoatra* but has smaller spores than either, does not possess the incrusted axial and often emergent hyphae of the spines and may be distinguished by the reddish and more fleshy subiculum. It does not turn purple in a potassium hydroxide solution.

Collected once in Iowa on basswood, Aug. 8, 1931. Reported from New Jersey by Cejp (1931) but the specimen is *Oxydontia fragilissima* (Berk. & Curt.) Miller as treated in this paper. Several specimens of *Odontia stenodon* (Pers.) Bres. from Bresadola at The New York Botanical Garden, two specimens of *Acia stenodon* (Pers.) Bourd. & Galz. from Bourdot at the Lloyd herbarium and a specimen of *Acia stenodon* (Pers.) Bourd. & Galz. from Litschauer have been seen. Several of these specimens cast doubt upon my determination. The specimen from Litschauer and one from Bresadola differ in having the spines more coalesced and more or less fimbriate, and spores which are distinctly curved.

The writer is indebted to Professor G. W. Martin for his advice and suggestions during the preparation of this paper.

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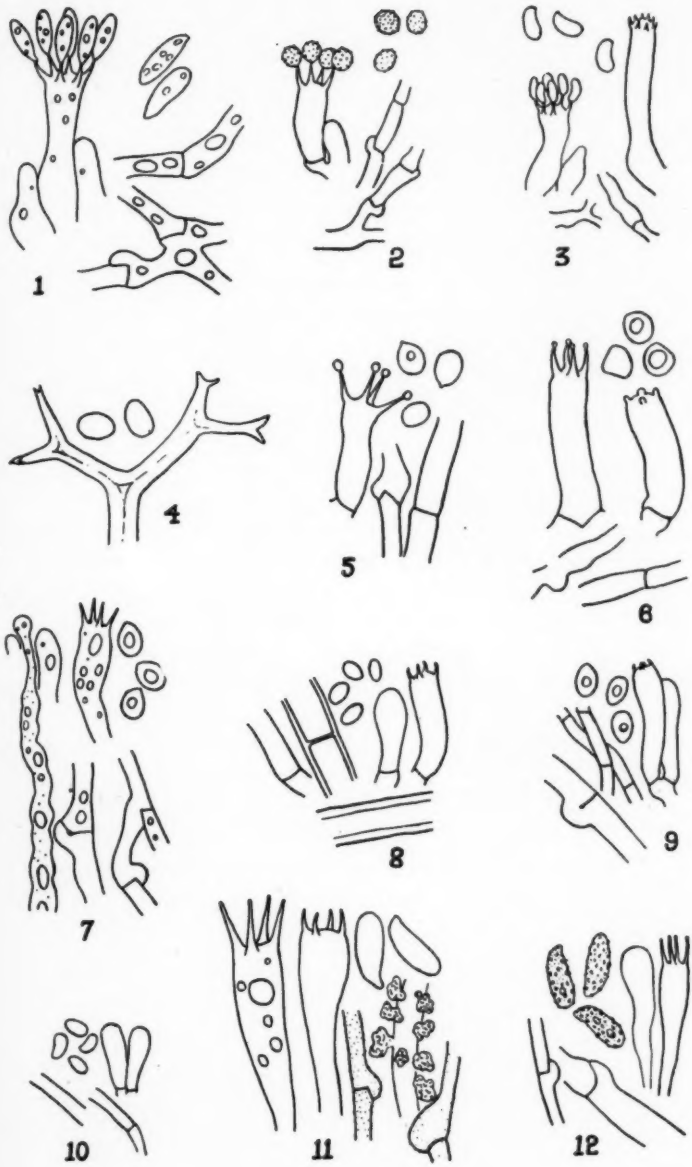
EXPLANATION OF PLATE 43

All figures drawn with camera lucida at a magnification of 1650 diameters, reduced to × 1000 in reproduction. Hyphae, basidia and spores are shown in each figure except figure 4 which includes only a characteristic antler-shaped structure and spores and figure 7 in which a gloeocystidium is added.

Figs. 1–6, *Grandinia:* 1, *G. raduloides;* 2, *G. farinacea;* 3, *G. Brinkmanni;* 4, *G. granulosa;* 5, *G. mutabilis;* 6, *G. helvetica.* Figs. 7–12, *Oxydontia:* 7, *O. macrodon;* 8, *O. fragilissima;* 9, *O. setosa;* 10, *O. stenodon;* 11, *O. Himantia;* 12, *O. alboviride.*



HYDNACEAE

AN UNDESCRIBED PHOMOPSIS FROM DOUGLAS FIR ON THE PACIFIC COAST

GLENN GARDNER HAHN

(WITH PLATE 44)

INTRODUCTION

During the spring of 1930 striking cankers on the green form of Douglas fir, *Pseudotsuga taxifolia* (LaM.) Brit., were collected by Prof. R. E. Smith, University of California and Mr. W. W. Wagener, at Lokoya, Napa County, California. A preliminary examination of the fungus which was found fruiting abundantly associated with the cankers, showed an organism closely related to *Phomopsis Pseudotsugae* Wilson (**5**), which previous investigation had shown to be the cause of canker and die-back of Douglas fir and other conifers in the British Isles and on the Continent (**6**, **7**). Inasmuch as the cankers from Douglas fir on the Pacific Coast were practically identical with those caused by the *Phomopsis* on the same host in Britain (**5**, figs. 14, 15, 17), it was economically important to determine whether these two organisms were morphologically and culturally identical.

It does not lie within the scope of this paper to discuss in detail the pathological phases of this problem. These will be found in a separate publication in which the symptoms and nature of the disease are discussed by Dr. J. S. Boyce,[1] who undertook a field study of the canker to determine its distribution. The present paper deals mainly with the mycological characters of the Californian fungus which is herein described below as a new species.

RELATIONSHIP OF THE NEW PHOMOPSIS TO OTHER PHOMOPSES OF CONIFERS

For the purpose of determining whether or not the *Phomopsis*, whose presence was made conspicuous as the result of a canker

[1] The discussion of the Douglas fir canker disease by Dr. J. S. Boyce will appear in the Journal of Forestry **31**: 1933 under the title, "A Canker of Douglas fir Associated with *Phomopsis Lokoyae*."

epidemic among young Douglas fir in 1930, was an undescribed species, careful morphological and cultural comparisons were made with four related species occurring on conifers—*P. juniperovora* Hahn, *P. occulta* Trav., *P. Pseudotsugae* and *P. Strobi* Sydow. These coniferous species were chosen for the reason that the measurements of the alpha or A-type spores (elliptic-fusoid or oblong-elliptical) belonging to this group did not differ greatly either in length or width.

Although the morphological characters of the fruiting body and the A-type spores of *P. occulta* and the new fungus were quite similar, the former produced a pronouncedly scolecosporic, beta or B-type spore (**2**) which was quite distinct from the shorter elongate type found in the latter. *P. occulta* which occurs commonly on a large number of coniferous genera including Douglas fir, both in this country and in Europe, has been proved culturally to be the imperfect stage of *Diaporthe conorum* (Desm.) Niessl. The perfect stage of the undescribed species, on the other hand, is at present unknown. This is also true in the case of the parasite, *P. juniperovora,* which causes blight and canker among cedar nursery stock in the Middle West and along the Atlantic seaboard. The filamentous B-type spores produced by the cedar parasite (**2**) unknown to occur naturally on Douglas fir, differed in shape and size and the A-type spores were slightly larger. The culture characteristics of the three species being compared were quite distinct.

It was found that the pycnidia formed by the new species from the Pacific Coast were typical for the genus *Phomopsis* (**1**) in that the spore-bearing cavity at inception was generally found to consist of a single chamber or locule which became somewhat irregular with pseudo-partitions or outgrowths from the side or lower walls of the fruit body. In this it differed from *P. Pseudotsugae* and *P. Strobi,* for as has been pointed out in a previous paper (**2**) the pycnidia of these are atypical in that they tend to become irregularly unilocular after fusion takes place among a number of previously-formed sporebearing cavities. Neither *P. Pseudotsugae* nor *P. Strobi* are known to produce B-type spores. Culturally the new *Phomopsis* differed from these two species.

It is of interest here to call attention to the fact that the cultural characteristics of *P. Strobi* have been found to be practically

identical with those of *P. Pseudotsugae*. In consequence the former species, which the author in earlier studies (**2**) intimated was very closely related morphologically to the latter, may very probably be considered a form of the earlier species recognized as a parasite on exotic Douglas fir in Europe. Further studies are now being undertaken with the purpose of demonstrating the perfect stage.

Measurements of spores from four collections of the undescribed *Phomopsis* (50 A-spores each) from different sources in California showed closely corresponding spore-size ranges. The frequency distributions of A- and B-spores are presented in Table 1.

TABLE 1

DIMENSIONS OF THE PYCNIDIOSPORES OF PHOMOPSIS LOKOYAE ARRANGED IN CLASSES

A-spores				B-spores			
Length		Diameter		Length		Diameter	
Class μ	No. of spores in 200	Class μ	No. of spores in 200	Class μ	No. of spores in 100	Class μ	No. of spores in 100
4– 4.9	1	1–1.9	1	9– 9.9	9	1–1.9	26
5– 5.9	7	2–2.9	76	10–10.9	31	2–2.9	72
6– 6.9	39	3–3.9	119	11–11.9	38	3–3.9	2
7– 7.9	73	4–4.9	4	12–12.9	12		
8– 8.9	53			13–13.9	7		
9– 9.9	23			14–14.9	3		
10–10.9	4						

The fungus was identified from cankers collected by Boyce on Douglas fir in Josephine County, Oregon, along the Pacific Highway just over the California state border. The dimensions of both A- and B-spores closely corresponded with the size range determined for the organism growing in California. The A-spores produced artificially on sterilized stems of Douglas fir (*Pseudotsuga taxifolia*, Colorado blue form) at ordinary room temperature were practically identical in size with those produced in nature.

In searching for an earlier collection of the organism in California, possibly identified under another name, the type specimen of *Phoma Pini* Cooke & Hark. (No. *1548*, Harkness Herbarium, Grevillea **9**: 81. 1881) collected on fir (dead bark) at Healds-

burg, Sonoma County, Calif., April 29, 1880 and deposited in the Herbarium of the California Academy of Science, San Francisco, was examined upon the suggestion of Dr. W. W. Diehl. Slides of the type prepared and deposited in the California Herbarium by Diehl showed the pycnidium of a fungus whose structure did not suggest a *Phomopsis.* A species of *Diplodia* also was found in the type specimen occurring abundantly. Another interesting specimen in the Herbarium, Mycological Collections, Washington, D. C., collected by the late Ellsworth Bethel in 1923 on *Pseudotsuga taxifolia,* Pikes Peak, Colorado, and determined by Diehl as *Phoma Douglasii* Oud. [*Sclerophoma Douglasii* (Oud.)] with elliptical spores, 8–9 × 3–3.5 μ, is neither a *Phoma* nor a *Phomopsis,* but appears to be as identified, a species of *Sclerophoma.*

In view of the distinguishing morphological and cultural characters of the Pacific Coast *Phomopsis* which differentiate the organism from every other coniferous *Phomopsis* studied, it is described accordingly as a new species:

Phomopsis Lokoyae sp. nov. Pycnidia closely aggregate, ectostromatic, embedded, arising among the cells of the periderm where the fruit body is more or less incorporated with the host tissue and becoming erumpent, fuscous-black; carbonaceous; cone-shaped, lenticular or subglobose, truncate (PLATE 44, FIGS. 1, 2); approximately two times as broad as high, mostly 300 to 565 μ in diameter and 175 to 300 μ in height; pycnidiospores emerging in a whitish tendril or globular gelatinous mass from a single locule or chamber lined with a hymenial layer of slender, flexuous, subulate, sub-acutely pointed sporophores 5–20 μ long (PLATE 44, FIG. 3), from the tips of which the spores are abstricted; cavity unilocular with protrusions from the side and basal walls forming pseudo-partitions, and with a thickened pseudo-parenchymatous layer above; occasionally with more than one locule. A-spores (PLATE 44, FIG. 4), unicellular, hyaline, variable in shape, elliptic-fusoid, oblong-elliptic, or oblong with obtuse or subacute extremities, commonly bi-guttulate, mostly 6–10 μ in length and 2–4 μ in diameter, extreme range, 200 spores, 4 collections, 4.8–10.0 × 1.6–4.0 μ; B-spores (PLATE 44, FIG. 5), hyaline, unicellular, somewhat scolecosporic, elongate, bilateral with obtuse or subacute extremities, minutely guttulate, mostly 10–12 μ in length and 1.5–2.5 μ in diameter, extreme range, 100 spores, 2 collections, 9.0–14.2 × 1.4–3.2 μ.

Pycnidiis discretis vel aggregatis; ab initio subepidermicis denique erumpentibus, carbonaceis, lenticularibus, conoideis, truncatis, vel subglobosis;

basibus complanatis, ostiolis paulo pertusis, vel deficientibus; contextu heterogeneo praeditis, matricibus fuligineis supra cavitates sporiferes incrassatulis; unilocularibus 175–300 μ alt., 300–565 μ diam. A-sporulis, hyalinis, continuis, ellipticis-fusoidiis, oblongis-ellipticis vel oblongis, guttulatis (200), 4.8–10.0 × 1.6–4.0 μ, vulgo 6–10 × 2–4 μ. Scolecosporulis, subfiliformibus, hyalinis, continuis, guttulatis, (100) 9.0–14.2 × 1.4–3.2 μ, vulgo, 10–12 × 1.5–2.5 μ. Basidiis, continuis, subulatis, tenuibus, brevibus, 5–20 μ.

Hab. In ramis et truncis vivis et emortuis *Pseudotsugae taxifoliae* (LaM.) Brit. in America boreali (California, Oregon) 1930.

The perfect stage is unknown. Perithecia were not produced in experiments in which mono-pycnidiospore strains were crossed in 3 per cent malt and ground oatmeal agar cultures. The single spore strains were isolated from cankers obtained from widely separated localities in California and Oregon.

Hab. The fungus has been observed on living and dead cankered Douglas fir (*Pseudotsuga taxifolia*), green form, in California and Oregon in 1930. The following collections of the organism were made in California in 1930: Napa County—F. P. *53025,*[2] R. E. Smith; F. P. *53026–7–8,* W. W. Wagener; F. P. *53032–6,* E. P. Meinecke, W. W. Wagener, and E. Wright; F. P. *53068,* J. S. Boyce; Trinity County—F. P. *53030–1,* E. P. Meinecke, W. W. Wagener and E. Wright; Mendocino County—F. P. *53711,* J. S. Boyce. A collection, F. P. *53061,* J. S. Boyce, was made the same year in Josephine County, Oregon.

A specimen and slide of the fungus (Type, F. P. *53025,* collected R. E. Smith, Lokoya,[3] Calif.) have been deposited in the Herbarium, Mycological Collections, Washington, D. C.

CULTURE NOTES

Strains of *Phomopsis Lokoyae* isolated from single spores and from inner bark tissue of cankers collected from different localities in California showed fair agreement as regards their cultural characters. The organism grew readily upon corn meal plus 2 per cent cane sugar, ground oat and 3 per cent malt agars. Upon the malt agar it produced at room temperature an olivaceous color in the midstratum somewhat hidden by a low-growing yet abundant whitish aerial hyphal growth. With age this olivaceous color darkened considerably and the whitish, aerial growth took on a thin and

[2] Number refers to collection in the Division of Forest Pathology.

[3] A summer resort among the Napa County hills.

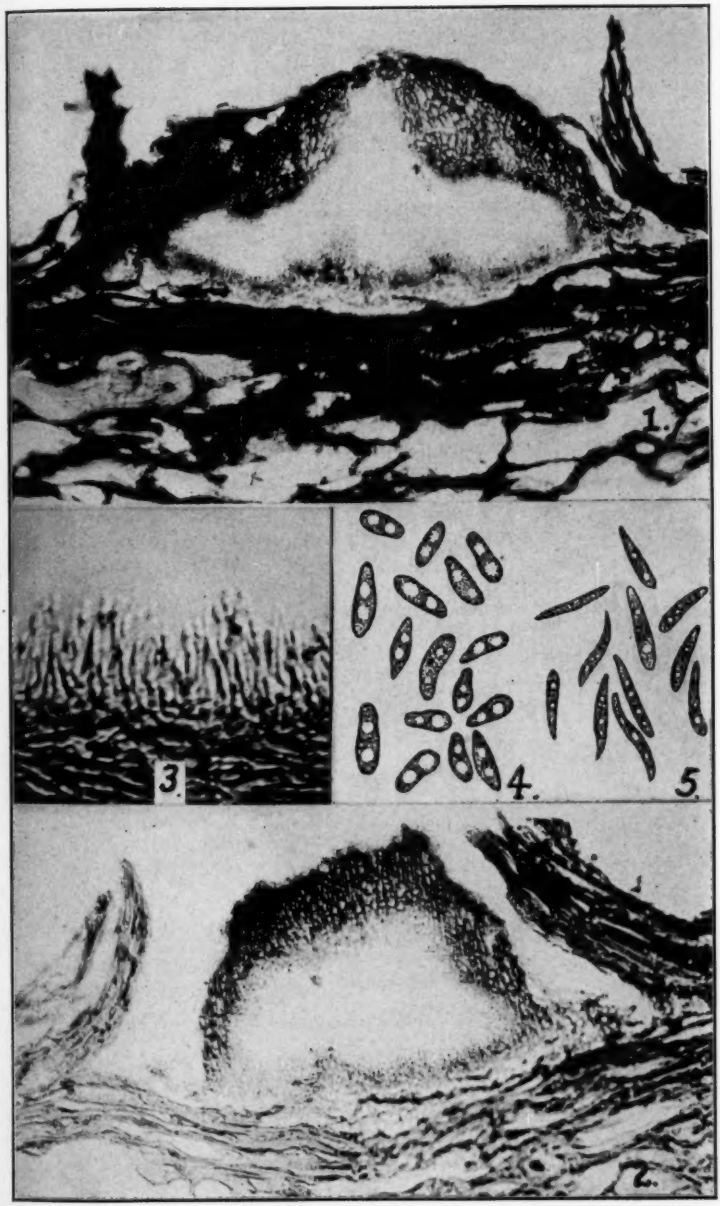
patchy appearance. Within three weeks whitish crystals had formed in the medium, which were observed to appear repeatedly upon further culturing.

These crystals were not observed to form in cultures of *Phomopsis Pseudotsugae* or *P. occulta*. As previously reported crystals formed in cultures have likewise aided in distinguishing other coniferous *Phomopses, e.g.,* the flaming red crystals produced in cultures of *P. juniperovora* served as a differentiating character in separating the cedar parasite from the non-crystal-forming innocuous saprophyte, *P. occulta*.

Unlike the other *Phomopses* species mentioned in this paper which sporulate abundantly under artificial conditions, *P. Lokoyae* did not fruit readily in culture. Upon both malt and oat agars it produced dark stromatic primordia but these were mostly sterile, forming spore-bearing cavities very reluctantly. The fungus was induced to fruit by growing it on sterilized Douglas fir twigs.

DISCUSSION

Phomopsis Lokoyae appears to be a distinct species among the coniferous *Phomopses* which the author has studied. It has never been observed in the East on planted Douglas fir nor has the organism been collected on the blue form of the host species in the Rocky Mountain region. On the Pacific slope it occurs only on the green form of Douglas fir within a limited range. As in the case of *P. abietina* (Hart.) Wilson & Hahn (*Phoma abietina* Hart.) a parasite of continental Europe, which forms cankers only on small branches of silver fir (*Abies pectinata* D. C.), *P. Lokoyae* likewise appears limited to a given host species. Boyce found the canker disease associated with *P. Lokoyae* to be locally epidemic during the dormant season of 1929–30 because of a combination of heavy rainfall in June, 1929 followed by a protracted drought. He regards the organism as native and one which has become evident as a result of the canker epidemic with which it has been found associated. The silver fir branch canker parasite in Europe has also been reported epidemic in certain years (**3**, **4**). It is not regarded by conservative pathologists there as serious but rather as one which does not become pathogenic until there arises a combination of conditions which favor its parasitic attack. This same statement very probably holds true for *P. Lokoyae*.



PHOMOPSIS

SUMMARY

A hitherto unrecognized species of *Phomopsis* on the Pacific Coast associated with a definite canker of young Douglas fir, *Pseudotsuga taxifolia*, is herein described as *P. Lokoyae* sp. nov. This organism is morphologically and culturally distinct from *P. Pseudotsugae* which previous investigation has shown to cause a similar canker of exotic Douglas fir in Europe. The western *Phomopsis* appears to be confined to a single host species and to a limited geographical range.

DIVISION OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
IN COOPERATION WITH THE
OSBORN BOTANICAL LABORATORY,
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EXPLANATION OF PLATE 44

Fig. 1, Pycnidium, *Phomopsis Lokoyae*, showing ostiole, × 360; 2, Pycnidium, *P. Lokoyae*, with well-developed pseudoparenchymatous tissue above sporebearing cavity, × 360; 3, Sporophores, × 1000; 4, A-spores, × 1100; 5, B-spores, × 1100.

NEW OR NOTEWORTHY AGARICS FROM OREGON[1]

S. M. Zeller

In this paper eight species are described as new and three new combinations are proposed. Sixteen species are listed as new to Oregon, and ten new to America are as follows: *Galerula pygmaeoaffinis* (Fries) Zeller, *Hypholoma dispersum* Fries, *Lactarius obnubilus* (Lasch) Fries, *Lepiota rhacodes* (Vitt.) Fries, *Naucoria escharoides* Fries, *Pleurotus limpidus* Fries, *Psalliota augusta* Fries, *P. dulcidula* Schulz., *Stropharia psathyroides* Lange, and *Tricholoma amplum* (Pers.) Rea. Types of the new species are in the Oregon State College Herbarium. Ridgway (**10**) was used as a color standard in the descriptions of new species.

1. Amanita muscaria Fries.

In sandy pine barrens along the ocean coast, in sandy loam along rivers or under poplars in various types of soil. Frequent. Always gregarious and in quantity. Usually from October to December but infrequently in the spring.

Kauffman (**3**) has given an interesting note concerning the distribution of different color forms of this species in America. At that time Kauffman was not familiar with *A. muscaria* on the Pacific coast, but several times since we have mentioned how our coastal form conforms in color to the dark red European form. More recently Kauffman (**5**) reported the scarlet form from Mt. Hood, Oregon. In the pine barrens along the coast the scarlet red form predominates but in the interior valleys and hill-lands of Oregon and Washington the well-known orange-yellow to pale yellow form, or the scarlet form may be found. Large fields of either form are often found. I am inclined with Professor J. E. Lange of Denmark, to the belief that the form which occurs com-

[1] Published as Technical Paper No. 194 with the approval of the Director of the Oregon Agricultural Experiment Station. Contribution from the department of Botany and Plant Pathology.

monly in eastern states is a distinct species. As stated above, both occur in Oregon.

2. **Armillaria granulosoides** sp. nov.

Gregaria: pileo 2–5 cm. lato, convexo, dein expanso vel plano-depresso, squamuloso vel erecto-squarroso, levi ochraceo demum cremeo et saepe rufo-tincto; carne tenui alba; lamellis latis confertis adnatis vel subdecurrentis saepe e stipite secedentibus albis vel cremeis, acie levis; stipite 2–5 cm. longo, 2–4 mm. crasso, utrimque rufescente vel fulvescente annulum peronato, squamis floccosis cremeis vel fulvis; anulo superiore tenui evanido; sporis curti-ellipsoideis hyalinis levibus 3–4.5 × 2–3 μ, saepe duonis vel quaternis.

Hab. ad terram muscosum ad margini silvarum coniferarum (*Pseudotsuga taxifolia*) prope Wren. Oregon Amer. bor. (*S. M. Zeller and E. M. Harvey*).

Pileus 2–5 cm. broad, convex, expanding to plane and usually depressed in center; *surface* squamulose scaly to erect squarrose, scales light ochraceous-buff to tawny, sometimes staining almost russet (drying light buff, pale ochraceous-buff to light ochraceous-buff), creamy or buffy between the scales; *flesh* thin, white to creamy; *gills* broad, close (not crowded), inserted, adnate to slightly decurrent, often breaking away, white to creamy (drying light buff), edges even; *stem* 2–5 cm. long, 2–4 mm. diam., rufescent to tawny above and below, peronnate with floccose to subfloccose scales to a slight fugacious floccose ring, scales creamy to tawny; *spores* short ellipsoidal, hyaline, 3–4.5 × 2–3 μ, often adhering in groups of 2, 3 and 4.

Gregarious; in mossy places at the margin of young Douglas fir growth, on the divide between Wren and Kings Valley, Benton County. Elevation 1300 ft. November. Collected by S. M. Zeller and E. M. Harvey.

In general appearance this plant is close to *Armillaria* (*Lepiota*) *granulosa* Fries from which it differs in several details. The trama of the stipe and pileus are continuous and the gills are adnate to almost decurrent. Kauffman has transferred the closely related species of *Lepiota* to *Armillaria*. For those who prefer the former disposal of these species this plant should bear the name, *Lepiota granulosoides*.

3. ARMILLARIA ROBUSTA Fries.

In sand under pines, Lane to Lincoln Counties, November. Frequent along the coast.

So far as the writer is aware this is the first report of this species

from the west. It is a large species reaching 18 cm. across and 15 cm. high. It agrees in every other particular with descriptions by European mycologists.

4. **Armillaria rugoso-reticulata** (Lorin) Zeller, comb. nov. (Syn. *Lepiota rugoso-reticulata* Larin).

In mixed woods, several locations in Benton County, November and December. Frequent in rather dense virgin forests.

Kauffman has reported this species from Michigan and the Siskiyou Mountains, Oregon (**6**). In the Oregon material the spores are 4–6 × 3–3.5. It is otherwise as described. The pileus is antimony-yellow to ochraceous-buff on the margin to buckthorn brown (**10**) on the disk when fresh, drying buckthorn brown to Dresden brown. The gills are adnate and the stipe is continuous with the trama of the pileus.

5. **Bolbitius marginatipes** sp. nov.

Gregaria vel subcaespitosa: pileo 1–4 cm. lato campanulato dein expanso membranaceo, levi vel innato-fibrilloso tenuiter glutinoso, tenuiter radiatim rugoso plicato-striato vel margine sulcato, centro glabro isabellino margine griseo vel griseo-albo; stipite fragili aequali cavo striatulo albo ad basem bulboso nigrofimbriato-marginato, 2–8 cm. longo, 2–3 mm. crasso; lamellis stipite adnatis tenuis, 1–1.5 mm. crassis, scissilis griseolis dein brunneis, acie levis; carne tenui alba; sporis ellipsoideis vel citriformis levibus, 12–14 × 7.5–9 μ, obscuro-ochraceis apice truncatis; cystidiis nullis visis.

Ad terram fimatam in viridariis Corvallis, Oregon Amer. bor. (*F. D. Bailey, B. F. Dana,* et *S. M. Zeller*).

Pileus membranous, conical, then expanded to almost plane, 1–4 cm. broad; *surface* smooth to innate fibrillose, somewhat viscid, somewhat radially rugose, plicate-striate to splitting ½ way up from margin in expanded plants, isabella color on disk and grayer toward margin in young plants to grayish white when mature; *stem* brittle, cylindrical from a marginate, bulbose base, margin distinct but blackish fimbriate above which stem is white, finely longitudinally striate, hollow, 2–8 cm. by 2–3 mm.; *gills* grayish, then ochraceous to antique brown (**10**) adnate, narrow (mostly about 1–1.5 mm.) with some very narrow (about ¼ mm.) splitting, thin, margins even; *flesh* white, membranous; *spores* dark ochraceous, broadly ellipsoid to citriform, with a hyaline apical germpore, 12–14 × 7.5–9 μ, smooth. *Cystidia* not seen.

On fertile manured soil in greenhouse; gregarious. January. Collected by F. D. Bailey, B. F. Dana and S. M. Zeller.

This material is very close to *B. titubans* (Bull.) Fries but dif-

ers in the color of the pileus and stem and in the striations on the stem and the marginate bulbose base, which suggests the name. The splitting takes place into the trama of the narrowest gills which open above, hinge-like on their edges as in several species of *Coprinus*. The young stages appear like *Coprinus*.

6. CANTHERELLUS CLAVATUS Fries.

Under conifers near Newport, Oregon. October.

Previously reported from the Olympic Mountains and Mt. Hood but in contrast this collection at the coast is of interest because of the range in altitude.

7. CLITOCYBE DEALBATA (Sow.) Fries.

In pastures and lawns. Very common. September to December. Although this species is so commonly found no definite report of it from Oregon has been recorded.

8. COPRINUS OVATUS Fries.

Five specimens were sent from Portland, Multnomah County, for identification.

This is the only collection so far reported from Oregon but undoubtedly should be referred here if this is a good species. The spores in this collection are 9–13.4 × 6–8.8 μ, the caps are ovoid and the whole plant reaches a maximum of 11 cm. Under our climatic conditions it is not unusual to find *C. comatus* reaching a height of 25–38 cm. Ricken (**9**) gives *C. ovatus* as a distinct species while Rea (**8**) considers it a variety of *C. comatus*.

9. FLAMMULA ALNICOLA Fries.

On the ground at the base of alders and on decayed alder stumps. Swim, Clackamas County. Collected and determined by J. E. Lange and the writer. Frequent. First report of this species west of Colorado (**3**).

10. FLAMMULA FLAVIDA Fries.

On coniferous wood along an old corduroy logging road, near Hemlock, Tillamook County. September. Frequent. Collected and determined by Jakob E. Lange and S. M. Zeller.

Longyear once found this species in Michigan, but this seems to be the first report from any western state unless *Gymnopilus flavidellus* Murrill may be the same.

11. GALERULA ANTIPUS (Lasch) Atkinson.

On horse dung, Rhododendron. September. Frequent. Collected by Jakob E. Lange and S. M. Zeller.

Spores are 8–10 × 6–7 μ, angularly 6-sided to limoniform. Previously reported from North Carolina.

12. **Galerula martipes** (Kauffm.) Zeller, comb. nov. (Syn. *Galera martipes* Kauffm. (**5**)).

Under conifers, Rhododendron. September.

13. **Galerula pygmaeoaffinis** (Fries) Zeller, comb. nov. (Syn. *Galera pygmaeoaffinis* Fries).

Under oak among scant grass. Northwest of Corvallis. December.

The material is hardly referable to any other described species. The pileus is distinctly sulcate and reticulately wrinkled. The spores in ours are 14–18.4 × 8–11.3 μ, with a prominent germ pore.

14. GOMPHIDIUS NIGRICANS Peck.

In mixed woods, Rhododendron; in coniferous woods near Newport. September–October. Infrequent.

Professor Jakob E. Lange and the writer first collected and identified the specimens from Rhododendron, and a few days later Mr. G. R. Hoerner brought in material from near the ocean beach (Newport). So far as we can find, this is the first report of this species from Pacific Coast States.

15. HYGROPHORUS PUNICEUS Fries.

In mossy woods, Coos County. February.

The Oregon plant seems in every way like that described in Europe but I find no record of the extremely foetid odor of the decaying plants. Growing, sound plants have a mild taste and odor.

16. HYPHOLOMA DISPERSUM Fries.

Under *Picea sitchensis*, near Beaver, Tillamook County, September.

This evidently is the first report of this species from America. Collected by Dr. Jakob E. Lange and the writer. Dr. Lange had no doubt of its identity.

17. LACTARIUS OBNUBILUS (Lasch) Fries.

Under alder trees or on alder wood, Rhododendron. September. Not uncommon. Collected by J. E. Lange and the writer.

18. LEPIOTA ERIOPHORA Peck.

Under conifers, Benton and Linn Counties. October. Infrequent.

The spores in ours are 3.5–4 × 2–2.5 μ, and they adhere in 2's and 4's.

19. LEPIOTA FLAMMEATINCTA Kauffm.

In mixed woods, Alsea Mountain, Benton County. December. One specimen was found which closely fits Kauffman's (4) description but the spores are broadly ellipsoid and measure 5–6 (7) × 3.5 (4), while Kauffman gives 8–9 × 4–4.5.

The pileus, stem above and below the annulus and the flesh change to red when touched or bruised. The gills remain white when bruised. It is close to *L. roseifolia* Murrill.

20. **Lepiota Kauffmani** sp. nov.

Gregaria: Pileo 2–5 cm. lato, campanulato dein expanso et umbonato: superficie arida "mars brown" (10), cute glabra demum concentricatim ramosa et carnem subalbam intersquamulam ostendente, disco glabro, margine integro non striato; lamellis liberis subcrassis ventricosis acie levis vel leniter granulosis; stipite gracili 5–8 cm. longo, 2–4 cm. crasso, deorsum angustato vel aequali, glabro, cremeo-albo vel sordido; annulo superiore albo delicatulo-membranaceo subpersistente mobili; sporis cuneiformis ad minor apicis rotundatis, levibus, hyalinis 4–5.5 (6) × 2.5–3 μ; basidiis clavatis 15–20 × 6–7 μ; cystidiis solum in acie lamellarum, saccatis-sphaeroideis vel abrupte clavatis hyalinis 17–21 × 10–14 μ; contextu cremeo, centro crasso margine tenui, sapore farinaceo vel parum ingrato, odore grato.

Ad terram in silvis, prope Alsea Mons, Oregon, Amer. bor. (*Mr. and Mrs. S. M. Zeller*).

Pileus 2–5 cm. broad, dry, at first campanulate expanding nearly plane umbonate, cuticle at first "Mars brown" breaking into concentrically arranged, small, fibrillose scales to the margin, with almost white flesh between, disk remaining even glabrous, Mars brown, margin not striate; *flesh* creamy, thin, thickened at the umbo; *gills* free, rather broad, ventricose, rounded behind, edges even to slightly granular; *stem* slender, 5–8 cm. long, 2–4 cm. thick, equal to slightly larger above, smooth, creamy white to sordid; *annulus* delicately membranous, superior, white, moveable; *spores* broadly truncate-cuneiform, rounded at smaller end, smooth hyaline, 4–5.5 (6) × 2.5–3 μ; *basidia* clavate, 15–20 × 6–7 μ; *cystidia* only on edge of gills, saccate-sphaeroid to broadly pyriform, hyaline, 17–21 × 10–14 μ; *odor* pleasantly fungoid, *taste* farinaceous to slightly disagreeable.

Gregarious in mixed woods and under thickets of broad-leaved bushes, Alsea Mountain. October. Collected by Mr. and Mrs. S. M. Zeller.

This species is closely related to *L. cuneatospora* Kauffm. and *L. fulvella* Rea. It has much smaller spores than either, and differs from the former in the distinct sterile cells on the edge of the gills, the color of the pileus and size of the basidia. It has no cystidia but the sterile cells on the edge of the gills are similar to the cystidia described by Rea for *L. fulvella*. The spores have a tendency to adhere in groups of 2's and 4's.

I take pleasure in dedicating this species to our late friend, Dr. C. H. Kauffman.

21. **Lepiota pulverapella** sp. nov.

Solitaria: pileo carnoso, 7–12 cm. crasso convexo vel plano-depresso; superficie arida "pecan brown" vel "Rood's brown" (**10**), mutans cacaotica brunnea, pulverulenta enatus squamis minutis erectis obseto; margine sterile ad maturitatem radiatim rimoso; contextu albo mutans sublutescens, tenui spongioso, centro 8–12 mm. crasso, sapore miti, odore farinaceo; lamellis liberis prope stipite albis sed arescendo carneis vel roseo- et vinaceo-tinctis 6–8 mm. crassis, acie levis vel leniter serrata; stipite 7–10 cm. longo, 1–1.5 cm. crasso sursam attenuato, utrimque glabro, albo tactu brunnescento, cavitate fibrillis sericeis leniter farcta; annulo membranaceo reflexo inferiore albo tactu brunnescento; sporis levis hyalinis ellipsoideo-ovatis, 6–7 × 4 μ.

Ad terram in pratis, prope Peoria, Oregon, Amer. Bor. (*S. M. Zeller*).

Pileus fleshy 7–12 cm. broad, convex to plane or depressed at umbo; *surface* dry, soft, pecan brown to Rood's brown, chocolate brown where bruised, about the same shade of color all over cap, general pulverulent appearance because of the upturned tips of tiny, squamulose scales, splitting somewhat toward the margin in mature specimens; *margin* sterile; *flesh* white changing slightly yellowish when bruised, 8–12 mm. thick at disk, thin toward margin, spongy; *gills* free, close to stem, white, drying a flesh color with darker rosy and vinaceous shades, 6–8 mm. broad, edges even to slightly serrate; *stem* 7–10 cm. long, 1.0–1.5 cm. broad, tapering upward, smooth above and below, white, changing chocolate brown where handled, hollow, stuffed sparingly with silky fibrils; *annulus* membranous, reflexed, below the middle of stem, white changing chocolate when bruised; *spores* smooth, white, 6–7 × 4 μ; ellipsoidal-ovate; *taste* mild; odor farinaceous.

Solitary, in open pastures, near Peoria, November.

This species is close to *L. americana* and very close to *L. Badhami*. From the description (**8**) of the latter, it differs in color of the pileus and flesh when bruised, and the gills are close to the stem.

22. LEPIOTA RHACODES (Vitt.) Fries.

Under frondose trees, Portland and Salem. October and November. In Oregon State College Herb. No. *5573*, and *5660*, and also distributed to Farlow Herb., Harvard University; The New York Botanical Garden Herb.; University of Michigan Herb.; and Missouri Botanical Garden Herb.

This Oregon material seems in every detail like the plant described in Europe. The colors are between those shown by Bresadola (**1**) and Ricken (**9**) and the spores are ovate, appear truncate at the distal end because of a germ pore (as also described for *L. brunnea* Farl. and Burt (**2**)), and measure 9–12 (12.3) × 6–7 μ. The one specimen sent in from Portland measured 22 cm. in diam. and 24 cm. tall.

Since *L. Brunnea* Farl. and Burt, the only American type previously referred to *L. rhacodes*, has proven to be a distinct species, the Oregon collections perhaps constitute the first actual report of this European species in North America. Because the New England species had previously been referred to *L. rhacodes*, I thought it desirable to report above the distribution of parts of an Oregon collection in eastern herbaria.

23. LEPIOTA ROSEIFOLIA Murrill.

In mixed woods, Alsea Mt., Benton County. October and December.

This species has many characteristics in common with *L. flammeatincta* Kauffman, and further experience may prove them to be the same. My collections have the bitterish taste; annulus white above and tawny below; pileus 6 cm. in diameter, flaming red when touched or bruised, the whole becoming very dark when dry; the flesh and gills, however, changing pink when cut or bruised. The spores are 7–9 × 4 μ.

24. LEPIOTA ROSEILIVIDA Murrill.

In mixed woods, Alsea Mt., Benton County. October. Infrequent.

Previously reported from Muirs Woods, California.

25. LEPIOTA SEQUOIARUM Murrill.

Under *Pseudotsuga taxifolia*, in open woods, near Lebanon, Linn County. October. Solitary.

This delicate species is easily characterized by the white pileus

with isabelline umbo. The spores in ours are ovate to ellipsoid, 7–8.8 × 3.5–4 μ. The stem is slender, 12 cm. long and 4 mm. thick. This is the first report of this species north of Muir Woods.

26. LEPTONIA FULIGINOSA Murrill.

In lawns, Corvallis. September to April. Common.

Described from Palo Alto, California.

27. **Naucoria alniphila** sp. nov.

Gregaria: pileo 4–8 (10) cm. lato carneo campanulato-convexo dein expanso et umbonato, viscido levi vel innato-fibrilloso, centro furfuraceo-fibrilloso, radiatim squamas innatas, margine translucido roseo-ochraceo, umbone fulvo-olivaceo vel badio; stipite 4–7 (8) cm. longo, 3–7 mm. crasso, pileo concolore vel sordido brunnescento, subaequali primo albo sericeo-fibrilloso veli reliquiis fibrillosis fugocibus consperso, dein sericeo-striato; lamellis adnatis vel raris sinuatis discretans leniter distans, 4–6 mm. crassis albo-fuscis vel ferrugineis; sporis ferrugineis ellipsoideis vel ovoideis, levis 5–7 × 3–4.5 μ; cystidiis numeriosis in superficie et in acie lamellarum, hyalinis capitato-lecythiformibus obtusis 50–60 × 14–18 μ.

Ad truncos et ramulos emortuuos et procumbens Alni, Alsea Mons, Oregon, Amer. bor. (*S. M. Zeller*).

Pileus 4–8 (10) cm. broad, fleshy, campanulate to hemisphaerical, then expanded, umbonate, smooth to innate-fibrillose, furfuraceous-fibrillose on umbo from which innate scales of similar surface radiate, viscid when wet, a translucent pinkish buff on the margin to darker toward the disk, umbo and scales tawny-olive to warm sepia; *stem* 4–7 (8) cm. long, 3–7 mm. diam., concolorous or dingy becoming brownish, equal or thickened upwards, silky or striate with scattered oppressed fibrils, when young sprinkled with white, silky fibrils, the remains of a rather ample, fugaceous *veil: gills* adnate to rarely sinuate, separating, moderately distant, 4–6 mm. broad, whitish fuscous, then ferruginous; *spores* ferruginous, broadly ellipsoid to ovoid, variable in size, 5–7 × 3–4.5 μ, smooth; *cystidia* numerous in hymenium and thickly set on edge of gills, all hyaline, capitate-flask-shaped, blunt, 50–60 × 14–18 μ.

Abundant on logs of *Alnus rubra*, Alsea Mt., Benton County, November to December. Frequent.

This fungus is extremely plentiful wherever found. The down logs at a distance appear distinctly spotted with them. The sporophores come singly but gregarious over the whole extent of the log or brush supporting them. They have been found by the writer on nothing but alder bark on trunks or stems which were cut not more than a year.

28. NAUCORIA ESCHAROIDES Fries.

Under alders in damp soil, Rhododendron, and frequently along creek bottoms. September to November. Common. Collected and identified by J. E. Lange and the writer. Unmistakeably the same as described by Rea (**8**) in England.

29. **Naucoria oregonensis** sp nov.

Gregaria: pileo 2–6 cm. lato primito campanulato (saepe margine introrse revoluto vel contracto) dein expanso vel subplano subumbonato; superficie sicco levi appresso-fibrilloso squamoso, centro "buckthorn brown" vel "Dresden brown," margine "pinkish buff" vel "tawny-olive," siccans "cinnamon-buff" vel "buffy brown" (**10**), contextu tenui albido vel cremeo; stipite 4–7 cm. longo, 7–10 mm. crasso cartilagineo firmulo vel fibroso-farcto albo vel cremeo levi subaequali; lamellis adnatis crassis ventricosis a fronte leniter crassioribus, confertis insertis, "clay color" vel "tawny olive" siccans "tawny olive" vel "Saccardo's umber" (**10**), hygrophanis acie subciliatis, pallidioribus; basidiis clavatis 25–29 × 6–7 μ; sporis ochraceis variabilis, fusiformis elongatis-ovoideis vel inaequalis-ellipsoideis, 9–13 × 4–6 μ; cystidiis subnumeriosis in superficie et in acie lamellarum, hyalinis variabilis longis-clavatis pyriformis, in apice interdum late rotundatibus vel mucronatibus, levibus vel verrucosibus, 50–60 × 6–10 μ protrudens 25–42 μ.

Plerumque circinatim ad terram in pratis, Coast Range, Benton County, Oregon, Amer. bor. (*S. M. Zeller*).

Pileus 2–6 cm. broad, at first campanulate (often with incurved or constricted margin) then expanding to nearly plane, subumbonate; *surface* squamose with appressed fibrillose scales, dull, dry, "buckthorn brown" to "Dresden brown" at the center and "pinkish buff" to "tawny-olive" at the margin, drying "cinnamon-buff" to "buffy brown"; *flesh* whitish to creamy, thin; *stem* 4–7 cm. long, 0.7–1.0 cm. thick, cartilaginous, solid to fibrous-stuffed, white to creamy, smooth, nearly equal; *gills* adnate, broad, ventricose, unequal, slightly wider in front, close, "clay color" to "tawny-olive," drying "tawny-olive" to "Saccardo's umber" (**10**), hygrophanous, margins lighter and almost ciliatulate due to the hyaline sterile cells; *basidia* clavate, 25–29 × 6–7 μ; *spores* fusiform, elongate-ovoid to unequilateral-ellipsoid, 9–13 × 4–6 μ, ochraceous ("clay color" to "tawny-olive" in mass); *cystidia* quite numerous, cylindro-clavate, hyaline, broadly rounded and mucronate to verrucose at tip, 50–60 × 6–10 μ (projecting 28–35 μ); *sterile cells* at margin of gills very much like cystidia, tips mostly smooth, some verrucosely-capitate, some pyriform, hyaline, projecting 24–42 μ, mostly 9–10 μ in diameter.

In pasture lands which have never been cultivated, forming "fairy rings" or "arcs" of rings, gregarious. Elevation 1000–

1500 ft. Common in hills of the Coast Range in Oregon. Type collected on divide between Wren and Kings Valley, Benton County. November and December.

30. NAUCORIA PELLUCIDA (Bull.) Quél.

On soil in the crowns of cultivated brambles and on the soil around orchard trees. Common throughout western Oregon during any period when the temperatures are nearly freezing. Through the winter from October to March.

This is the first report of this species from the northwest. In ours the spores are 7–9 × 3.5–5 μ but in every other way agrees with descriptions and illustrations by Europeans. (Ricken and Rea).

31. NOLANEA MAMMOSA Fries.

Growing from small bits of decayed wood in mixed woods, Alsea Mt., Benton County. October. Frequent.

Since first identifying this species it has been found generally in our mixed woods, especially under maple, hemlock, or dogwood. It is a beautifully trim species. The spores of ours measure between those given by Bresadola, Rea, and Ricken, mostly 11–14 × 7–8 μ.

32. NOLANEA PASQUA Fries.

Under conifers, near Hemlock, Tillamook County. September. Rather common in Oregon but not often found in the Eastern U. S. Has characteristically 4-angled spores.

33. PAXILLUS PANUOIDES Fries.

On logs of *Pinus contorta,* Taft, Lincoln County. Very infrequent. November.

This is the first report of this species from Oregon although it has been collected in Washington and California.

34. **Pholiota scabella** sp. nov.

Solitaria: pileo convexo vel plano-expanso 6–10 cm. lato, sicco squamoso vel subsquarroso nitente, cute separabili, ochraceo, quia directonis lucis variabili "buff" vel "Dresden brown" (**10**); carne 8–12 mm. crassa alba vel cremea; lamellis adnatis in lineis solum decurrentibus, subaequalibus a fronte angustioribus, 4–5 mm. crassis, confertis, "Saccardo's umber" vel "sepia" (**10**), in acie undulatibus; stipite radicato 7–9 cm. longo, 1.5–2.0 cm. crasso, robusto, subaequali vel sursum leniter tenuito solido intus albido deorsum squamoso, cremeo tactu ochraceo vel obscuriore sursam squarroso albido-luteo; annulo membranaceo persistenti mediano deflexo 3–4 mm. lato, quia sporis fuscescens; basidiis hyalinis clavatis, 4-sporis, 16–18 × 5–6 μ;

cystidiis sparsis truncato- vel mucronato-clavatis, hyalinis 28–35 × 7–10 μ; sporis lato-ellipsoideis purpureo-brunneis 5–7 × 3–4 μ; sapore acri-amaro, odore qualis rami nonnullus salicinus fractus.

Ad terram in silvis coniferis prope Lebanon, Oregon, Amer. bor. (*S. M. Zeller*).

Plants solitary, radicate; *pileus* hemisphaeric to plano-expanded, 6–10 cm. diameter; *surface* dry, squamose to subsquarrose, shiny, with pellicle which peels off, ochraceous, buff to Dresden brown according to angle of light; *flesh* thick, 8–12 mm. thick, white to creamy; *gills* adnate with a striate line on the stem (not a tooth), Saccardo's umber to sepia, narrow, 4–5 mm. broad, narrower in front than behind, almost equal, close (not crowded), edges wavy; *stem* radicate, 7–9 cm. long, 1.5–2.0 cm. thick, stout appearance, almost equal, slightly tapering upward, solid and whitish within, squamose scaly below annulus, squarrose above, ivory yellow above, cream-buff below staining ochraceous-buff or darker where bruised; *annulus* membraneous, persistent, 3–4 mm. broad, median, deflexed, colored by the purplish-brown spores; *basidia* hyaline, 4-spored, clavate, 16–18 × 5–6 μ; *cystidia* rare, truncately to mucronately clavate, hyaline, 28–35 × 7–10 μ; *spores* broad ellipsoid purplish-brown, 5–7 × 3–4 μ. *Taste* bitterish acrid. *Odor* like certain green crushed stems (willow-like).

In dense coniferous woods, near Lebanon. October. Infrequent.

This species must be similar to *Stropharia sienna* Kauffman, but differs in surface of the pileus, colors, spores and annulus. Although the cap is dry, its shiny rough surface gives it a changeable color at various angles of light. The colors range from golden hues to dark dull brown. Close to *Pholiota duroides* Peck. For those who segregate species having scaly stems into the genus *Hypodendrum*, this becomes *Hypodendrum scabella* Zeller.

35. PLEUROTUS LIMPIDUS Fries.

On *Alnus*, near Hemlock, Tillamook County. September. Determined by Jakob E. Lange.

36. PSALLIOTA AUGUSTA Fries.

Under very dense *Pinus contorta* and *Picea* spp., between Waldport and Yachats, Lincoln County, Corvallis, Benton County, and Tillamook County. August to December. Frequent.

P. augusta is closely allied to *P. subrufescens* which also occurs in western Oregon. The latter has smaller spores, 6–7 × 4–5 μ, and the gills are white at first, then pink becoming black-brown.

In *P. augusta* the spores are 8–12 × 4–7 (14 × 7.5) μ, and the gills are white at first, then gray becoming black-purplish-brown.

37. **Psalliota cervinifolia** sp. nov.

Gregaria vel caespitosa: pileo 10–20 cm. lato hemisphaeroideo vel convexo-expanso, disco fusco, squamulis subdensis minutis fibrillosis fuscis appressis vestito, saepe margine levi et pallidiore, dein saepe squamulis ampliore consperso, tactu lutescens; contextu albo tactu lutescens postice crasso, margine tenui, odore et sapore grato; lamellis liberis subcrassis (15 mm. cr.) confertis "light vinaceous fawn" dein cervinis vel cinnamomeis et brunneolonigris; stipite 8–16 cm. longo 2–3.5 cm. crasso subaequali leniter bulboso, farcto dein cavo, prope lamellarum glabro vel leniter innato-fibrilloso, demum albo-griseo vel "light mouse gray" (**10**), tactu obscuriore rubro-brunneo annulo supero collarioideo, 4–8 mm. lato, simplici persistenti albo tactu brunnescens: sporis oblongis vel ovoideis levis purpureo-brunneis 4 × 5–6 (7) μ.

Ad terram fimatam ad margini silvarum coniferarum, Lincoln et Linn counties, Oregon Amer. bor. (*S. M. Zeller*).

Pileus 10–20 cm. broad, hemisphaeroid to convex expanded, fuscous on the disk, covered by rather dense, small fibrillose, fuscous, appressed scales, sometimes almost glabrous toward margin and paler, sometimes breaking into larger scales at maturity, yellowish when bruised; *flesh* white turning slightly yellowish when bruised, thick on disk, thin on margin; *gills* free, moderately broad (up to 15 mm. broad at maturity), crowded, pale vinaceous fawn at first, then fawn to cinnamon-drab, finally bone brown (dark purplish brown); *stem* 8–16 cm. long, 2–3.5 cm. thick, subequal, slightly bulbous, stuffed then hollow, glabrous to slightly innate-fibrillose near the gills, whitish gray to light mouse gray when older, darker reddish brown where handled; *annulus* superior, collar-like, 4–8 mm. broad, persistent, white to stained brownish where bruised, simple; *spores* mostly 4 × 5–6 μ (rarely 7 μ), oblong to ovoid, purplish brown, smooth; *odor* and *taste* pleasant.

Gregarious to cespitose. In very fertile soil in the margins of coniferous forests where horses had been pastured. Linn and Lincoln counties, Oregon. November. Infrequent.

This plant has relationships to *P. haemorrhodaria* Fries, *P. sanguinaria* Karst. (*sensu* Lange), and *P. silvatica* Fries (*sensu* Bresadola), but is larger than these and differs in the color of the pileus and gills, and in characters of the annulus.

The specific name is given for the fawn color of the gills at medium development.

38. PSALLIOTA DULCIDULA Schulz.

In mixed woods among moss, Rhododendron. September. Solitary. Infrequent.

Characterized by the whitish cap with light brownish disk, pallid grayish gills which become almost black, yellowish stains on the stem, and the small size of the entire plant. It has not been previously reported from this country unless it is the same as *P. comptuloides* Murrill. The latter, however, seems stouter and the annulus larger.

39. PSALLIOTA SUBRUTILESCENS Kauffm.

In dense mixed woods, Alsea Mt., Benton County. November. Frequent. This relatively new species is not uncommon in the woods of the Coast Range as well as the Cascade Mountains (**5**).

40. RUSSULA FALLAX Fries.

Low damp places in woods, Rhododendron, Clackamas County. September. Collected by J. E. Lange and the writer. Frequent.

This species was previously reported from the west by Kauffman (**5**). The plants we observed were sordid purplish, almost black somewhat olivaceous on the disk but soon fading at maturity to sordid whitish; flesh white, acrid to peppery. The Pacific Coast plants evidently are not so light colored as Kauffman reports from Michigan but more nearly as Lange describes in Denmark.

41. RUSSULA FURCATA Fries.

In mixed woods, Newport. October. Infrequent.

This green *Russula* as found in Oregon, is in nearly every particular as described by European workers. The spores are 7–8.5 × 5.3–6 and the colors of the cap are exactly as shown by Bresadola (**5**, *pl. 404*) for well expanded specimens. Some of ours are "tawny-olive" at the disc and "Roman green" (**10**) nearer the margin.

42. STROPHARIA PSATHYROIDES Lange.

In moss under *Alnus*, near Beaver, Tillamook County. September.

This plant was observed in the field by Prof. Jakob E. Lange and the writer. According to Prof. Lange this is the first report of the species outside of Denmark (**7**).

43. TRICHOLOMA AMPLUM (Pers.) Rea.

In large clumps along roadside in open mixed woods, about 1 mile south of Helmick Park, Polk County. November. Uncommon.

Our plant is the same as described and illustrated by Bresadola (**1**), but not *sensu* Ricken (**9**).

44. TRICHOLOMA CALIFORNICUM Murrill, Mycologia **5**: 223. 1913.

Syn. *Armillaria subannulata* Peck, Bull. Torrey Club **36**: 330. 1909.

Melanoleuca californica Murrill, Mycologia **5**: 216. 1913.

Melanoleuca subannulata (Peck) Murrill, N. Am. Flora **10**: 30. 1914.

Tricholoma subannulatum (Peck) Zeller, Mycologia **14**: 187. 1922. [Not *T. subannulatum* Batsch. See Bresadola (**1**, *pl. 63*).]

In lawns and heavy trodden soil under deciduous trees, Corvallis.

This species appears late in the fall each year in the same location where I first studied it in 1922. Since then I have watched the plants with interest and find several characters which were not included in previous descriptions. The taste is mild but not pleasant and the odor though usually farinaceous is often musty. The rugose character of the gills previously mentioned (1922) is very apparent in older specimens. Besides the transverse striations there are also frequently ridged veins on the gills radiating from the point of attachment to the stem. The spores are broadly ellipsoid, 5–7 × 3.5–4.5 μ (mostly 5 × 3.5) but with one large oil drop so large and conspicuous that at times all of the spores in a microscopic mount might easily be observed as spherical but a good lens will reveal the much less distinct cell wall.

This species has already been roughly handled by mycological taxonomists under the names appearing above, but since *Tricholoma subannulatum* Batsch is applied by some European mycologists to another plant, this Pacific Coast plant is listed here as *T. californicum* Murrill.

45. TRICHOLOMA IONIDES (Bull.) Fries.

In open lawns and pastures; common throughout the Willamette Valley. October to December.

This species forms " fairy rings " but does not stimulate growth of grass like *T. sordidum* and *Marasmius oreades*.

46. TRICHOLOMA SORDIDUM (Schm.) Fries.

In lawns, Corvallis. November to January.

This is difficult to distinguish from some of the other purplish-lilac species of *Tricholoma* but the rosy spores are characteristic and in Oregon it forms " fairy rings " in lawns. On the campus of the Oregon State Agricultural College are numerous fairy rings resulting from lawn infections by *Marasmius oreades* but there are also several rings resulting from *T. sordidum*. The grass is killed out at the margins by both fungi but the stimulated growth of grass following *Marasmius oreades* is more extreme than that following *T. sordidum*.

47. TRICHOLOMA SUBPESSUNDATUM Murrill.

In mixed woods and under conifers, Alsea Mt., Benton County, and Newport, Lincoln County. Frequent. October to December.

This species is very similar in appearance to *T. californicum* Murrill but differs in color of pileus and gills, and in the shape of spores.

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NOTES ON SOME SPECIES OF COLEOSPORIUM—III

GEORGE G. HEDGCOCK AND N. REX HUNT

This paper is a continuation of a series, the first numbers of which were printed in 1922.[1] In the earlier papers, the following species of *Coleosporium* were considered: *C. delicatulum*,[2] *C. Helianthi*, *C. inconspicuum*, *C. Ipomoeae*, *C. ribicola*, *C. Solidaginis*, and *C. terebinthinaceae*. It was shown that these species are distinct from one another in their uredinial and telial host affinities, and their aecial morphology.

In 1920 [3] it had been shown that the aecial forms hitherto classed under *Coleosporium carneum* belonged to two distinct species, and *C. Elephantopodis* was set apart from *C. carneum*. Much of the data from inoculations with these two species have never been published and will be given in this paper.

1. COLEOSPORIUM CARNEUM

From 1913 to 1920, 135 sets of inoculations were made with aeciospores of *Coleosporium carneum* collected from 13 species of pine. Of these sets of inoculations, 18 were made with aeciospores taken from the needles of *Pinus caribaea* More., 20 from *P. echinata* Mill., 30 from *P. palustris* Mill., 43 from *P. taeda* L., and 24 from other species. 1037 plants of 7 species of *Vernonia* were inoculated, of which 220 plants of all 7 species were infected. Mature uredinia were produced in 11 to 15 days, and mature telia in about two months. In addition, 817 plants of 79 species of *Aster, Amsonia, Campanula, Coreopsis, Elephantopus, Eupatorium, Euthamia, Heterotheca, Ipomoea, Laciniaria, Parthenium,*

[1] Hedgcock, G. G., and Hunt, N. R. Notes on some species of *Coleosporium*—I, II. Mycologia **14**: 244–257, *pl. 20, 21*, 297–310, *pl. 22, 23*. 1922.

[2] The nomenclature for rusts is that followed by Dr. J. C. Arthur, in Uredinales. N. A. Flora, Vol. 7. 1907, 1924, 1927.

[3] Hedgcock, G. G., Hahn, G. G., and Hunt, N. R. New species and relationships in the genus *Coleosporium*. Mycologia **12**: 182–198. 1920.

Pharbitis, Quamoclit, Senecio, Silphium, Solidago, and *Verbesina* were inoculated without infection.

In all the inoculation experiments given in this paper an equal number of plants were set aside as a control and remained free from infection. All the experiments were conducted in the greenhouses of the United States Department of Agriculture in Washington, D. C. The records and data are filed for consultation in the card catalogue of the Division of Forest Pathology.

From 1913 to 1920, 12 sets of inoculations were made with the urediniospores of *Coleosporium carneum* obtained from 3 species of *Vernonia.* 40 plants were inoculated, 8 plants of species of *Aster,* 2 of *Coreopsis,* 2 of *Euthamia,* 7 of *Heterotheca,* 9 of *Solidago,* 4 of *Verbesina,* and 8 of *Vernonia.* 7 plants of *Vernonia* were infected bearing uredinia and telia. The plants of the other species remained free from infection.

From 1913 to 1920, 5 sets of inoculations were made with the sporidia from germinating teliospores of *Coleosporium carneum,* chiefly in the month of September. 86 trees of 24 species of pine were inoculated. 27 trees of 10 species were infected, bearing pycnia from the following December to February, and aecia from February to April. Aeciospores from these trees were used in the inoculations previously given. *Pinus contorta* Loud. and *P. ponderosa scopulorum* Engelm. are now reported for the first time as proven hosts for pycnia and aecia.

2. COLEOSPORIUM ELEPHANTOPODIS

From 1914 to 1920, 46 sets of inoculations were made with the aeciospores of *Coleosporium Elephantopodis* collected from 8 species of *Pinus,* 13 from *P. caribaea,* 16 from *P. palustris,* 11 from *P. taeda,* and 6 from other species. 98 plants of 3 species of *Elephantopus* were inoculated, of which 74 plants were infected, bearing mature uredinia in 11 to 13 days and telia in about two months. 220 plants of 54 species of *Aster, Coreopsis, Euthamia, Helianthus, Heterotheca, Ipomoea, Laciniaria, Parthenium, Pharbitis, Senecio, Silphium, Solidago, Vernonia,* and *Verbesina* were inoculated at the same time without infection.

From 1914 to 1919, 10 sets of inoculations were made with the urediniospores of *Coleosporium Elephantopodis* collected from 3

species of *Elephantopus*. 73 plants of 3 species of *Elephantopus* were inoculated. Of these, 51 plants were infected bearing uredinia and telia. 31 plants of 1 species of *Heterotheca*, 2 of *Solidago*, and 4 of *Vernonia* were inoculated at the same time without infection.

From 1915 to 1920, 7 sets of inoculations were made, chiefly in September, with the sporidia from teliospores of *Coleosporium Elephantopodis*, from 7 collections on 2 species of *Elephantopus*. 150 trees of 25 species of *Pinus* were inoculated. Of these 43 trees of 8 species were infected, bearing pycnia from the following December to February, and aecia from February to April. Aeciospores from the trees were used in the inoculations previously given.

3. COLEOSPORIUM LACINIARIAE

From 1915 to 1919, 10 sets of inoculations were made with the aeciospores of *Coleosporium Laciniariae* collected from 3 species of *Pinus*. 37 plants of 7 species of *Laciniaria* were inoculated, of which 17 plants of 6 species became infected, bearing uredinia in 15 days and telia in about two months. At the same time, 94 plants of 26 species of *Aster, Coreopsis, Elephantopus, Euthamia, Helianthus, Heterotheca, Parthenium, Pharbitis, Silphium, Solidago, Vernonia,* and *Verbesina* were inoculated without infection.

In 1915, two sets of inoculations were made with the urediniospores of *Coleosporium Laciniariae* taken from the leaves of *Laciniaria graminifolia*. 10 plants of 6 species of *Laciniaria* were inoculated, of which 6 plants were infected, bearing mature uredinia in 15 days, and telia in two months. At the same time, 15 plants of 7 species of *Coreopsis, Helianthus, Heterotheca, Silphium,* and *Solidago* were inoculated without infection.

4. COLEOSPORIUM HETEROTHECAE

The senior writer has studied and collected for several years a form of *Coleosporium* occurring very commonly and abundantly on *Heterotheca subaxillaris* in Florida. In previous publications [4] this plant was wrongly referred to as *Chrysopsis mariana*, and wherever the latter name was used in giving the results of inoculations with various species of *Coleosporium* the former name should

[4] L. c. 1 and 3.

be substituted. A meager specimen of a species of *Peridermium* on the needles of *Pinus palustris* differing from any previously described form, was found in Florida, closely associated with this *Coleosporium* but no inoculations have been made to prove its relation, if any, to it. This *Coleosporium* maintains itself very effectively by wintering over on the rosettes of the host species, a habit common to several species of *Coleosporium* in the southern states. At first this form was doubtfully assigned to *Coleosporium Solidaginis,* but all attempts to prove its relationship to this and to other species of the genus have failed.

In testing the susceptibility of *Heterotheca subaxillaris* to species of *Coleosporium* from 1915 to 1920, 110 plants in fine growing condition were inoculated with the aeciospores of 8 other species of *Coleosporium,* as follows: 17 with *Coleosporium carneum,* 7 with *C. delicatulum,* 15 with *C. Elephantopodis,* 10 with *C. Helianthi,* 14 with *C. inconspicuum,* 14 with *C. Ipomoeae,* 13 with *C. Laciniariae,* and 20 with *C. Solidaginis.* All the plants inoculated remained free from infection.

The urediniospores of 6 species of *Coleosporium* were also used during the same period to inoculate 28 plants of *Heterotheca subaxillaris* as follows: 6 with *Coleosporium carneum,* 6 with *C. Elephantopodis,* 5 with *C. Helianthi,* 3 with *C. Ipomoeae,* 4 with *C. Laciniariae,* and 4 with *C. Solidaginis.* All the plants inoculated remained free from infection.

Two sets of inoculations were made in 1926 with the urediniospores of the *Coleosporium* from *Heterotheca subaxillaris* on 63 plants of 12 species known to be susceptible to species of *Coleosporium.* The following plants were inoculated: 3 of *Aster paniculatus,* 8 of 2 species of *Coreopsis,* 6 of *Elephantopus carolinianus,* 10 of 2 species of *Helianthus*; 10 of *Heterotheca subaxillaris,* 8 of 2 species of *Solidago,* 9 of *Verbesina laciniata,* and 9 of 2 species of *Vernonia.* Eight plants of *Heterotheca subaxillaris* were infected, bearing uredinia in about 15 days, but the leaves were shed before mature telia were formed. All the other plants inoculated remained free from infection. The *Coleosporium* from *Heterotheca subaxillaris* is now described as a new species.

Coleosporium Heterothecae sp. nov.

Soris uredosporiferis hypophyllis, subinde etiam epiphyllis, sparsis vel aggregatis, rotundatis vel ellipsoideis, 4.5–7 mm. crassis max nuclis, pulverentis aurantiacis, dein pallida flavis; unredosporis globosus, ovatis, vel ellipsoideus, verrucosis, 16–24 × 11–16 μ, episporio hyalino 0.7–1.5 μ crasso.

O and I Pycnia and aecia unknown.

II. Uredinia usually hypophyllous, sometimes epiphyllous, few to very numerous, small, circular to elliptic in outline, 0.45–0.7 [5] mm. across, averaging 0.6 mm., orange chrome fading with age to nearly white; urediniospores sphaeroid to ovoid or ellipsoid, 11–16 by 16–24 μ, averaging 13 by 19 μ, with walls slightly thickened at the apex, 0.7–1.5 μ in diameter, averaging 1 μ, verrucose with small conical tubercules.

Type collection on *Heterotheca subaxillaris* (Lamb.) Britton from East Mayport, Florida, collected by G. G. Hedgcock March 11, 1916. Known only from Florida. No mature telia have been collected.

Heterotheca subaxillaris was formerly called *Inula subaxillaris* Lamb. *Coleosporium Inulae* Rabh. occurs on *Inula Vaillantii* and plants of other genera in Europe, Asia, and Africa. The urediniospores of this species are 17–23 μ by 20–35 μ; those of *Coleosporium Heterothecae* are 11–16 μ by 16–24 μ, being much narrower and considerably shorter.

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[5] Based on 100 measurements.

RUSTS OF THE NORTHWEST HIMALAYAS [1]

J. C. Arthur and George B. Cummins

(with 2 text figures)

The Uredinales reported in this paper were collected by Dr. R. R. Stewart in the Northwest Himalayas. The species listed here were collected in India, in the Punjab, Kashmir, the Northwest Frontier Province and in the neighborhood of Mussoorie in the United Provinces (fig. 1).

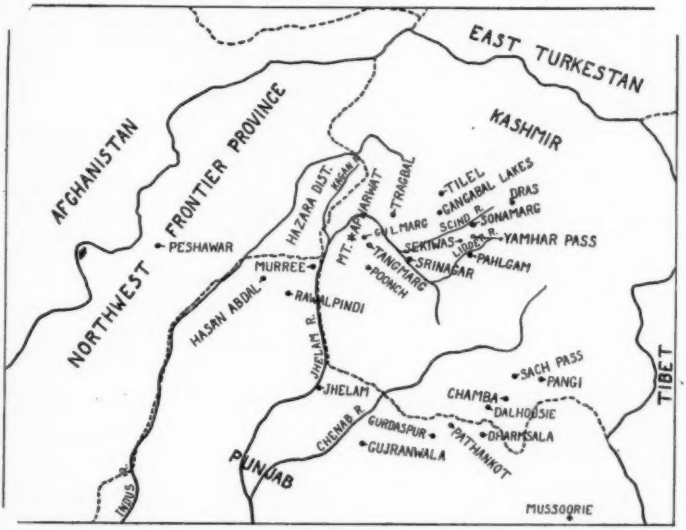

Fig. 1. A map of northern India to show the region in which Stewart collected the rusts reported in this paper.

This list contains 89 species comprising 165 collections, including 5 new species and 2 new combinations. There are 20 species of rusts marked with a double asterisk and 34 species of hosts in

[1] Contribution from the Botany Department, Purdue University Agricultural Experiment Station, Lafayette, Indiana.

addition to those given with new records of Indian rusts, marked with a single asterisk which are not recorded by Butler and Bisby in "The Fungi of India," 1931, or by Sydow (Ann. Myc. **31**: 84–88. 1933). Such species are considered to represent new records for India.

The writers wish to acknowledge their indebtedness to Dr. R. R. Stewart, collector, and to Dr. F. J. Seaver who transmitted for study that portion of Dr. Stewart's collections composed of rust fungi.

AECIDIUM CRYPTICUM Kalchbr. & Cooke, *Gerbera gossypina* Mussoorie, July 18, 1930, *11007*; Murree Hills, Charial, Sept. 7, 1918, *4006*.

****Aecidium distinctum** Arth. & Cumm., sp. nov.

Pycnia epiphylla, subepidermalia. Aecia hypophylla, maculis orbiculares usque 5 mm. diam. insidentia, gregaria, cupulata; cellulis peridii rhomboideae, 16–22 × 24–30 μ, pariete exteriore 8–11 μ cr., striato, interiore 2–3 μ cr., verrucoso; aeciosporae globosae, 16–20 × 18–24 μ; episporio 1.5–2 μ cr., ad apicem usque 4–8 μ cr., hyalino, verrucoso.

On *Angelica glauca*, Tragbal, July 26, 1919, *4662*.

AECIDIUM FLAVESCENS Barclay, **Senecio chrysanthemoides*, Pahlgam, Aug. 1920, *5900½*; Sept. 6, 1920, *5955*.

No material of Barclay's species has been available for comparison but Stewart's collection agrees with the published account. From a comparison of the aecia it seems probable that this species belongs with *Puccinia silvatica* Schröt., or a closely related form with telia on Carex.

AECIDIUM GIRARDINIAE Sydow, *Girardinia heterophylla*, Jabbar Khet, Mussoorie, June 2, 1930, *10821*.

****Aecidium Hederae** Arth. & Cumm., sp. nov.

Pycnia amphigena, subepidermalia, tumores efficientia. Aecia hypophylla, 1–2 mm. lata, irregulariter disposita, cupulata; cellulis peridii cubiceae, 16–20 μ lata, partiere exteriore 3–4 μ cr., striato, interiore 2–3 μ cr., verruculoso; aeciosporae globosae, 12–16 μ diam., episporio 0.5–1 μ cr., hyalino, minute verruculoso.

On *Hedera himalaica*, Murree Hills, Punjab, June 1928, *10525* (type); Charehan, Murree Hills, May 28, 1920, *5202*.

This species causes distortion of the leaves and petioles. The aecia are broadly cup-shaped with the peridium rupturing irregularly and breaking away at the surface of the host.

**AECIDIUM LOPHANTHI P. Henn., undetermined mint, Alwas, Chamba, June 23, 1917, *2366*.

In the type collection the apical thickening of the aeciospore-wall is more pronounced but otherwise the two collections agree well.

AECIDIUM MONTANUM Butler, **Berberis chitria*, Mussoorie, 1930, K. N. Gupta, *13279*; *B. lycium*, Barian, May 27, 1929, *10219*; Murree Hills, Punjab, June 1928, *10524*; Dharmsala, Punjab, June 1929, *10249*; *B.* sp., Dalhousie, June 1, 1917, *2185*.

AECIDIUM ORBICULARE Barclay, **Clematis connata*, Pahlgam, July 23, 1920, *5387½*; *C. grata*, Changla Gali, Murree Hills, May 27, 1929, *10228*; **C. montana*, Pahlgam, July 22, 1920, *5381*; *C.* sp. Upper Chenab, July 13, 1917, *2865½*.

This *Aecidium* morphologically is very like the aecia of *Puccinia rubigo-vera* (DC.) Wint., and may belong with that species.

****Aecidium Stewartii** Arth. & Cumm., sp. nov.

Pycnia amphigena, subepidermalia. Aecia hypophylla, aequaliter denseque distributa, totam follii superficiem occupantia, cupulata; cellulis peridii rhomboideae, 18–22 × 23–28 μ, partiere exteriore 3–6 μ cr., striato, interiore 2–3 μ cr., verrucoso; aeciosporae ellipsoideae vel globosae, 20–26 × 24–31 μ, episporio 1.5 μ cr., pallide brunneo, verrucoso.

On *Justicia quinquecangularis* ?, Gurdaspur Dist. Punjab, Febr. 18, 1917, *1318*.

AECIDIUM sp., *Lactuca* ?, Dalhousie, 7000 ft., June 13, 1917, *2232*.

AECIDIUM sp., on *Epilobium roseum*, Upper Lidder Valley, Naftan, Aug. 1931, *12521*.

The aecia are not systematic as in known autoecious species and may represent an undescribed form belonging to some heteroecious species.

CHNOOPSORA BUTLERI Diet. & Sydow, *Adhatoda vasica*, Pathankot, May 1917, *1698*.

CHNOOPSORA SANCTI-JOHANNIS (Barclay) Diet., **Hypericum lysimachioides*, Landour, Mussoorie, May 1931, *12603*.

CHRYSOMYXA DEFORMANS (Diet.) Jacz., *Picea Smithiana*, Dalhousie, June 13, 1917, *2164½*.

COLEOSPORIUM CAMPANULAE (Pers.) Lév., *Campanula canescens* Saidpur near Rawalpindi, Mar. 25, 1922, *6977*.

COLEOSPORIUM CLEMATIDIS Barclay, *Clematis montana*, Gharial,

Murree Hills, Sept. 6, 1918, *4004*; Ghora Gali, Murree Hills, Oct. 1931, *12397*.

CRONARTIUM RIBICOLA (Lasch) Dietr., **Ribes orientale*, Gulmarg, Kashmir, Aug. *22*, 1929, *10528*.

GAMBLEOLA CORNUTA Massee, *Mahonia nepalensis*, Landour, Mussoorie, May 1931, *12522*.

GYMNOSPORANGIUM CUNNINGHAMIANUM Barclay, **Cotoneaster bacillaris*, Landour, Mussoorie, Aug. 21, 1930, *11207*.

****Gymnosporangium distortum*** Arth. & Cumm., sp. nov. (FIG. 2, A & B).

Pycnia caulicola vel foliicola, subepidermalia. Aecia caulicola vel hypophylla, tumores efficientia et totam superficiem occupantia, 1–2 mm. alta, 0.5–1 mm. lata, fimbriata; cellulis peridii oblongae 16–20 × 60–90 μ, partiere exteriore 3 μ cr. levi, exteriore 8–12 μ cr., rugoso vel papillato; aeciosporae ellipsoideae vel globosae, 20–24 × 24–29 μ; episporio 2–2.5 μ cr., cinnamomeo-brunneo, rugoso, poris germ. 6–8.

On *Cotoneaster bacillaris*, Tragbal, Kashmir, July 2, 1919, *4372 (type)*; Alwas, Chamba State, June 27, 1917, *2451*; *C. rosea*, Gurais, July 1, 1919, *4314*.

The infected twigs and leaves are considerably distorted and bear pycnia and aecia on the entire infected area. The peridium becomes finely fimbriate to the base. The peridial cells bear short ridges or elongate papillae on the inner surface and transversely across the lateral wall.

MELAMPSORA AECIDIOIDES (DC.) Schröt., *Populus alba*, Nasim Bagh, Kashmir, July 1929, *10621*.

MELAMPSORA HELIOSCOPIAE (Pers.) Wint., *Euphorbia helioscopia*, Pathankot, Febr. 12, 1917, *1130*; *E. pilosa*, Sonamarg, Kashmir, Sept. 2, 1917, *3526*, Sept. 5, 1917, *3602*; Tragbal, Aug. 5, 1919, *4890*; **E. Wallichii*, Mt. Apharwat, Kashmir, Aug. 15, 1929, *10471*; above Gulmarg, Kashmir, Aug. 31, 1929, *10500A*.

MELAMPSORA LARICIS-CAPREARUM Kleb., *Salix* sp., Dalhousie, June 11, 1917, *2180*.

OCHROPSORA SORBI (Oud.) Diet., *Anemone sp.*, Alwas, Chamba, June 26, 1917, *2431*.

**OPLOPHORA CEDRELAE (Hori) Sydow, *Cedrela serrata*, Kalel, Chamba, June 21, 1917, *2328*.

PERIDERMIUM BREVIUS (Barclay) Sacc., *Pinus excelsa*, Dharmsala, May 22, 1917, *1962*.

PERIDERMIUM ORIENTALE Cooke, *Pinus longifolius,* Nadi, Dharmsala, May 25, 1917, *1994*; Landour, Mussoorie, May 1931, *12485A.*

PERIDERMIUM PICEAE (Barclay) Sydow, *Picea Smithiana,* Dalhousie, June 9, 1917, *2164.*

PHRAGMIDIUM BARCLAYI Diet., *Rubus lasiocarpus,* Tragbal, Kashmir, July 20, 1919, *4780.*

This collection is so named with some hesitation. Epiphyllous, subcuticular pycnia are present accompanied by teliospores that germinate at once. No aecia or uredia are present. Future collections may show this to represent a distinct microcyclic species.

PHRAGMIDIUM BUTLERI Sydow, *Rosa macrophylla,* Changla Gali, May 27, 1929, *10212*; above Gulmarg, Kashmir, Aug. 1929, *10641*; Mussoorie, June 2–4, 1929, *10884*; *R.* sp., Dalhousie, June 13, 1917, *2229.*

PHRAGMIDIUM DISCIFLORUM (Tode) James, **Rosa webbiana,* Sonamarg, Kashmir, Sept. 5, 1917; *R. sp.* Rawalpindi, Dec. 4, 1916, *368a.*

Phragmidium Kamtschatkae (Anders.) Arth. & Cumm., comb. nov. (*Puccinia Rosae* Barclay, Jour. Asiatic Soc. Bengal **58**: 233. 1889, not *Puccinia Rosae* Pers. Syn. Fung. 230. 1801, or Schum. Enum. Pl. Saell. **2**: 235. 1803; *Puccinia Kamtschatkae* Anders. Jour. Myc. **6**: 125. 1890; *Gymnoconia Rosae* Liro, Ured. Fennicae 413. 1908; *Teleconia Rosae* Sydow, Ann. Myc. **19**: 168. 1921; *Phragmidium Rosae* Tranz., see E. & P. Nat.-Pfl. 2te Aufl. **6**: 63. 1928, not *Phragmidium Rosae* Rostr. Plante-patologie **227**. 1902).

On *Rosa* probably *R. Webbiana,* Gangabal Lakes, July 4, 1919, *4423.*

Lindroth (Fauna Fl. Fenn. **20**[9]: XXIII. 1901) has pointed out that Barclay's name *Puccinia Rosae* is antedated, as is indicated in the synonymy given above. *Puccinia Kamtschatkae* Anders., becomes then the first valid name applied to this species. *Phragmidium Rosae* of Tranzschel is antedated by Rostrup's use of this combination for *Phragmidium disciflorum* (Tode) James. The fungus should, therefore, be called *Phragmidium Kamtschatkae.*

PHRAGMIDIUM POTENTILLAE (Pers.) Karst., *Potentilla fragarioides,* Alwas, Chamba, June 1917, *2386*; **P. Kleiniana,* Poonch, Apr. 1, 1931, *13280.*

PHRAGMIDIUM ROSAE-MOSCHATAE Diet., *Rosa moschata,* Dharmkot, Dharmsala, May 26, 1917, *2027*; **R. macrophylla,* Alwas, Chamba State, June 27, 1919, *2444*; *R. Webbiana,* Pahlgam, Sept. 4, 1920, *5892.*

PUCCINIA ABSINTHII DC., **Artemisia sieversiana,* Lower Scind Valley, Kashmir, Sept. 7, 1922, *7467½.*

**PUCCINIA AINSLIAEAE Sydow, *Ainsliaea pteropoda,* Jabberkhet, Mussoorie, Sept. 8, 1930, *11442.*

**PUCCINIA ARGENTATA (Schultz) Wint., *Adoxa moschatellina,* Sonamarg, July 7, 1928, *9808.*

PUCCINIA BARBEYI (Roum.) Magn., **Asphodelus tenuifolius,* Rawalpindi, Mar.–Apr., 1930, *13281.*

PUCCINIA BUPLEURI-FALCATAE (DC.) Wint., **Bupleurum jucundum,* Sonamarg, July 27, 1922, *7209.*

**PUCCINIA CALTHAE Link, *Caltha palustris* var. *alba,* Dharmsala, May 1917, *1917½*; (no locality given) July 1920, *5598;* Pahlgam, Sept. 4, 1920, *5906.*

PUCCINIA CHAEROPHYLLI Purt., **Chaerophyllum villosum,* above Gulmarg, Kashmir, 1929, *10364.*

PUCCINIA CHRYSOPOGI Barclay, *Jasminum humile,* Alwas, Chamba, July 2, 1917, *2575½.*

PUCCINIA CIRCAEAE Pers., *Circaea alpina,* Sonamarg, Aug. 31, 1917, *3453*; var. *himalaica,* above Gulmarg, Kashmir, Aug. 19, 1929, *10494*; var. *intermedia,* Sonamarg, Aug. 30, 1917, *3441.*

PUCCINIA CORONATA Corda., **Elaeagnus umbellata,* Chenari, Kashmir, July 3, 1931, *12175*; *Rhamnus virgatus,* Dharmsala, May 31, 1917, *2071½*; *R. purpureus,* Dalhousie, June 13, 1917, *2218*; *R. virgatus,* Dharmsala, May 26, 1917, *2008*; Dalhousie, June 11, 1917, *2188*; Kagan Valley, Hazara district, July 1–7, 1920, *6034.*

PUCCINIA CREPIDIS-SIBERICAE Lindr., *Crepis sibirica,* Sonamarg, Kashmir, Aug. 23, 1921, *6777½.*

PUCCINIA DUTHIAE Ellis & Tracy, **Andropogon ischaemum,* near Mogli Bungalow, Jhelam District, Punjab, Jan. 5, 1917, *747.*

PUCCINIA EPILOBII-TETRAGONI (DC.) Wint., **Epilobium roseum,* Yamhar Pass, Kashmir, Sept. 1931, *12474A.*

PUCCINIA EXCELSA Barclay, *Phlomis setigera,* Gulmarg, Kashmir, 1929, *10481.*

PUCCINIA EXTENSICOLA Plowr., *Aster asperulus,* Mussoorie, July 19, 1930, *11008.*

**PUCCINIA ? FESTUCAE Plowr., *Lonicera parvifolia,* above Gulmarg, July 30, 1926, *8636.*

PUCCINIA GENTIANAE (Str.) Link, **Gentiana decumbens,* Tragbal, Kashmir, July 24, 1919, *4597.*

PUCCINIA GERANII-SILVATICI Karst., **Geranium aconitifolium,* Gulmarg, Kashmir, 1929, *10506*; **G. pratense,* Tilel, Kashmir, July 2, 1919, *4337, 4337½.*

PUCCINIA GLUMARUM (Schum.) Erikss. & Henn., *Hordeum vulgare,* Nadi, Dharmsala, May 26, 1917, *2015.*

PUCCINIA GRAMINIS Pers., **Berberis pseudumbellata,* Tangmarg, Kashmir, July 1931, *12226.*

**PUCCINIA HERACLEI Grev., *Heracleum candicans,* Changla Gali, Murree Hills, Aug. 27, 1918, *3958*; Mt. behind Srinagar, July 19, 1919, *4134*; Sonamarg, July 27, 1922, *7204.*

This collection differs somewhat from the usual collections of *P. Heraclii* in that the aeciospores are smaller, 15–20 × 20–25 μ, but the aecia are badly parasitized. No other spore-form is present.

PUCCINIA HIERACII (Schum.) Mart., *Hieracium crocatum,* Sonamarg, Aug. 25, 1921, *6804.*

PUCCINIA KOMAROVI Tranz., **Impatiens Thomsoni,* Tragbal, Aug. 7, 1919, *4868*; Pahlgam, Sept. 6, 1920, *5952*; Sonamarg, Aug. 15, 1921, *6662*; Sonamarg, July 24, 1922, *7167*; above Gulmarg, Kashmir, July 1929, *10651*; *I.* sp., Changla Gali, Murree Hills, Oct. 1924, *7693.*

PUCCINIA MENTHAE Pers., *Mentha sylvestris,* Hasan Abdal, Dec. 6, 1916, *316*; Gharial, Murree Hills, Sept. 7, 1918, *4024.*

PUCCINIA MONTICOLA Kom., *Polygonum tortuosum,* Dras, Ladak, Kashmir, Aug. 31, 1922, *7426½.*

PUCCINIA NEPALENSIS Barclay & Diet., **Rumex acetosa,* above Gulmarg, Kashmir, July 1929, *10652.*

PUCCINIA NITIDA Barclay, **Polygonum filicaule,* Gulmarg, Kashmir, Aug. 13, 1929, *10448.*

**PUCCINIA OPIZII Bubák, *Lactuca* probably *decipiens,* Alwas, Chamba, July 3, 1917, *2651.*

PUCCINIA PIMPINELLAE (Str.) Mart., *Pimpinella diversifolia,* Changla Gali, Murree Hills, Sept. 12, 1922, *4051.*

PUCCINIA POLLINIAE Barclay, *Strobilanthes dalhousianus,*

Gharial, Murree Hills, Sept. 2, 1918, *3982*; Murree, Sept. 4, 1918, *3990*; Ghora Gali, Murree Hills, Oct. 1931, *12407*; *S.* sp., Dalhousie, June 7, 1917, *2126*; Landour, Mussoorie, July 11, 1930, *10989*.

PUCCINIA POLYGONI-AMPHIBII Pers., *Geranium Wallichianum*, Jabberkhet, Mussoorie, July 19, 1930, *11020*; *G.* sp., Purana Tilel, Kashmir, July 2, 1919, *4458*.

**PUCCINIA PRAECOX Bubák, *Crepis kashmirica*, Sonamarg, Kashmir, Aug. 16, 1922, *7333½*; Sonamarg, Kashmir, Aug. 11, 1928, *9884*.

PUCCINIA PROPINQUA Sydow & Butl., **Andropogon ischaemum*, Topi Park, Rawalpindi, Dec. 4, 1916, *368*.

PUCCINIA PRENANTHES-PURPUREAE (DC.) Lindr., **Lactuca* ? *decipiens*, Sonamarg, July 27, 1922, *7213*.

**PUCCINIA PULSATILLAE Kalchbr., *Aconitum moschatum*, Tragbal, July 24, 1919, *4635*; *Anemone tetrasepala*, above Gulmarg, Kashmir, Aug. 1926, *8753*; Banehal Pass, July 1, 1931, *12216*; *A.* sp., Sonamarg, Sept. 5, 1917, *3607*.

PUCCINIA RUBIGO-VERA (DC.) Wint., **Aquilegia pubiflora*, Murree Hills, Punjab, June 1926; *A. vulgaris*, Dharmsala, May 28, 1917, *2048*; Dharmsala, May 1917, *2069*; *A.* sp., Pahlgam, July 1920, *5380*; **Thalictrum minus*, Sach Pass, Chamba, July 3, 1917, *2662*; Sonamarg, July 27, 1922, *7203*; *T.* sp., Pahlgam, Kashmir, July 22, 1920, *5353*; *Triticum* sp., Khangah Dogran, Gujranwala District, Mar. 11, 1917, *1447*.

PUCCINIA SAXIFRAGAE-CILIATAE Barclay, *Saxifraga ciliata*, Alwas, Chamba, June 29, 1917, *2511*; Murree Hills, May 27, 1929, *10215*; **S. Stracheyi*, Sonamarg, Kashmir, Aug. 19, 1922, *7353*; Mt. Apharwat, Kashmir, Aug. 12, 1929, *10408*; Sekiwas, Upper Lidder Valley, Sept. 1931, *12523*.

****Puccinia silvaticella** Arth. & Cumm., sp. nov. (FIG. 2, c).

Telia peiolata vel hypophylla, aggregata, confluentia, pulverulenta, cinnamomeo-brunnea; teliosporae oblongae, 16–20 × 28–40 μ, ad apicem rotundatae vel truncatae, ad basim attenuatae, medio leniter constrictae; episporio 1.5 μ cr., ad apicem 4–8 μ cr., castaneo-brunneo, levi; pedicello hyalino, sporam aequante vel breviore.

On *Taraxacum officinale*, above Gulmarg, Kashmir, Aug. 1926, *8744*.

This species undoubtedly represents the correlated microform of

Puccinia silvatica Schröt. The micro-telia have the general habit of the aecia of the full-cycle species and the teliospores of both forms show a close similarity. Pycnia are not formed.

**PUCCINIA SWERTIAE (Opiz) Wint., *Swertia petiolata,* Mt. Apharwat, Kashmir, 1929, *10317*; *S. speciosa,* above Gulmarg, Kashmir, 1929, *10433*.

**PUCCINIA THLASPEOS Schub., *Draba lanceolata,* Hunan Nullah, Pangi, Chamba, July 9, 1917, *2773*.

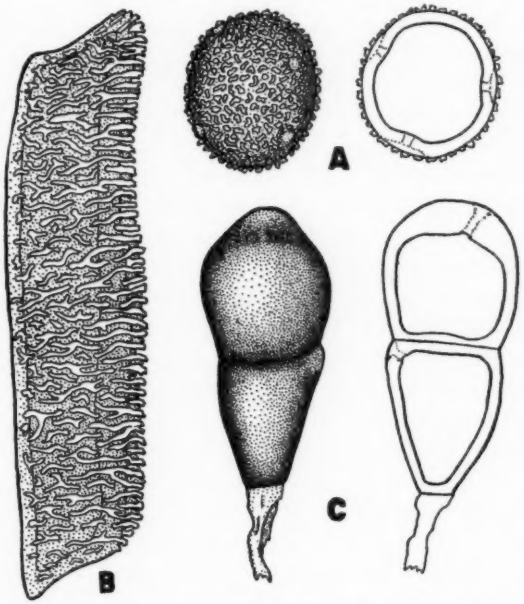

FIG. 2. A, these drawings in perspective and optical section show the rugose, relatively thick spore-wall of the aeciospores of *Gymnosporangium distortum*; B, a peridial cell of *G. distortum* illustrating the papillose to transversely ridged surface characteristic of the peridial cells of this species: C. perspective and optical section of the teliospores of the microcyclic species, *Puccinia silvaticella.* (Drawn with the aid of a camera lucida at a magnification of 1250 diameters.)

**PUCCINIA TROLLII Karst., *Anemone polyanthes* ?, Alwas Chamba State, June 27, 1917, *2437*.

PUCCINIA CARICIS (Schum.) Schröt., *Urtica* sp. (no locality given), June 2, 1917, *2097*.

PUCCINIA VIOLAE (Schum.) DC., **Viola biflora,* Pahlgam, July 22, 1920, *5350*; *V.* sp., Sonamarg, Sept. 5, 1917, *3576½, 3604.*

PUCCINIA WATTIANA Barclay, **Clematis grata,* Kalel to Masrund Chamba, June 22, 1917, *2344½*; Jhelam Valley Road, Kashmir, Sept. 15, 1917, *3779*; Lidder Valley, Sept. 6, 1920, *5986.*

PUCCINIOSTELE CLARKIANA (Barclay) Diet., *Astilbe rivularis,* Changla Gali, Murree Hills, May 27, 1929, *10213.*

**UROMYCES ACONITI Fuckel, *Aconitum lycoctonum,* Sonamarg, July 21, 1921, *6358*; Sonamarg, July 27, 1922, *7214.*

UROMYCES ANDROPOGONIS-ANNULATI Sydow & Butler, **Andropogon ischaemum,* Khangah Dogran, Gujramwala District, Mar. 11, 1917, *1444.*

**UROMYCES FRITILLARIAE (Schl.) Thüm., *Fritillaria Roylei,* above Gulmarg, Kashmir, July 1929, *10653.*

UROMYCES GERANII (DC.) Otth & Wartm., **Geranium pratense,* Sonamarg, Kashmir, Aug. 8, 1928, *9868, 9868a*; *G.* sp., Sonamarg, Kashmir, Aug. 19, 1922, *7401½.*

**UROMYCES HEDYSARI-OBSCURI (DC.) Car. & Picc., *Hedysarum cachemirianum,* Sonamarg, Sept. 4, 1917, *3758.*

UROMYCES POLYGONI (Pers.) Fuckel, *Polygonum aviculare,* Pahlgam, July 26, 1920, *5443.*

UROMYCES SCIRPI (Cast.) Burr., *Scirpus* sp., Gurdaspur, Mar. 3, 1917, *1365.*

UROMYCES TRIFOLII (Hedw. f.) Lév., *Trifolium resupinatum,* Islamia College, Peshawar, May 11, 1929, *10195.*

Uromyces Valerianae-wallichii (Diet.) Arth. & Cumm., comb. nov. (*Uredo Valerianae-wallichii* Diet. Ann. Myc. **4**: 303. 1906), **Valeriana pyrolaefolia* (no locality given), Sept. 5, 1917, *3604½*; *V. Wallichii* (no locality given), Sept. 5, 1917, *3577½*; Tragbal, Kashmir, July 30, 1919, *4767*; Changla Gali, Murree Hills, May 27, 1929, *10218*; above Gulmarg, Kashmir, 1929, *10496.*

Telia are present in three of the five collections accompanied by the characteristic urediospores. The telia are mainly epiphyllous, in small circinating groups or scattered, light chocolate-brown, pulverulent; teliospores globoid or obovoid, 21–25 × 24–29 μ, usually rounded at both ends; wall 2.5–3 μ thick, chestnut-brown, the pore apical; pedicel colorless, short, fragile.

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STUDIES CONCERNING HETEROECIOUS RUSTS [1]

E. B. MAINS

The studies reported in this paper were made as opportunities and materials offered during the course of investigations of the leaf rust of the grasses, the results of which have been given elsewhere (**1933**). A number of the cultures were made possible through the kindness of the late Mr. E. Bethel, to whom the writer is specially indebted for material and clues concerning connections based on his discriminating field observations.

PUCCINIA MONOICA Arth.

In 1920, telia (*10920*) [2] were received from Mr. Bethel who had collected them on *Stipa* sp. at Tuckee, California, August 27. These were found to be germinable and were sown September 1, 1920, on *Arabis* sp. and *Sidalcea candida*. No signs of infection were noted until May 10, 1921, when pycnia showed on the *Arabis*. The infected shoots of the *Arabis* were apparently filled with a systemic mycelium and the pycnia were widely distributed over the leaves of such shoots. Aecia developed about a week after the pycnia.

In the spring of 1921, aecia on *Arabis* sp. (Ara. 2) collected by Mr. Bethel May 25, 1921, at Boulder, Colorado, were sown on *Koeleria cristata, Stipa minor, S. pulchra,* and *S. viridula*. Infection was obtained only on *Koeleria cristata*.

Arthur (**1912**b) has reported that inoculations from aecia on Arabis sp. produced infection on *Trisetum spicatum* (*T. subspicatum*). *Koeleria cristata* and *Stipa viridula* gave negative results. In another experiment (**1915**) inoculations from aecia on *Arabis*

[1] Most of the cultures reported in this article were made while the writer was a member of the Department of Botany, Purdue Agricultural Experiment Station and the Office of Cereal Crops and Diseases, United States Department of Agriculture. Papers of the Department of Botany and the Herbarium of the University of Michigan No. 417.

[2] The designations of collections are the accession numbers of the writer.

sp. gave infection on *Koeleria cristata* while *Trisetum spicatum* gave negative results.

Apparently, as suggested by Arthur, *Puccinia monoica* contains several races. These may be designated as follows: sp. f. *Koeleriae* on *Koeleria cristata*; sp. f. *Triseti* on *Trisetum spicatum* (*T. subspicatum*). Another race apparently also is specialized to species of *Stipa.*

Puccinia conspicua sp. nov.

Arthur (**1918**) described *Aecidium conspicuum* Arth. from aecia on *Dugaldia Hoopesii.* The type was collected by J. C. Arthur and F. D. Kern at Snowball Creek near Pagosa Springs, Colorado, August 6, 1912.

In 1921, aecia (Dug. 1) were received from Mr. Bethel who had collected them May 30, on *Dugaldia Hoopesii* in the type locality for the *Aecidium.* At the time, he noted that *Koeleria cristata* closely associated with the aecia was showing uredinia. The aecia were used to inoculate *Koeleria cristata* resulting in the development of uredinia two weeks later. The rust on *Koeleria cristata* was multiplied by reinoculation and was then used to inoculate *Oryzopsis miliacea, Stipa comata, S. lepida, S. pulchra, S. viridula,* and *Koeleria cristata* resulting in the development of uredinia only on *Koeleria cristata.* Reinoculations on this species resulted in the development of a few telia.

In North America two rusts, *Puccinia Stipae* Arth. and *P. Liatridis* Bethel, have been reported on *Koeleria cristata* with aecia on species of the Carduaceae. The aecia of *Puccinia Stipae* differ markedly from those on *Dugaldia.* Although the latter are very similar to the aecia of *Puccinia Liatridis,* the uredinia and telia produced by *Aecidium conspicuum* on *Koeleria cristata* differ in several important respects from those of *Puccinia Liatridis,* the urediniospores being narrower and longer and the teliospores much shorter. Apparently this rust on *Koeleria cristata* is undescribed.

The species may be characterized as follows:

Syn. *Aecidium conspicuum* Arth. Bull. Torrey Club **45**: 153. 1918. Sydow, Monog. Uredinearum **4**: 42. 1924.

Uredinis amphigeniis, demum nudis, elongatis, 0.2–1.0 (2.0) mm. longis, flavo-brunneis; urediniosporis oblongo-ellipsoideis, 14–19 × 24–38 μ; tunica

pallide brunnea vel pallide flava, 1.5–2.5 μ crassa, modice et minute echinulata: poris 4–6, obscuris, sparsis.

Teliis amphigeniis, tarde nudis, 0.2–1.0 mm. longis, castaneo-brunneis: teliosporis irregulariter ellipsoideis vel clavatis, 20–28 × 28–40 μ; tunica, flavo-brunnea, 1 μ crassa, apice irregulariter rotundatis vel truncatis, incrassatis (5 μ); pedicello brevissimo.

On *Koeleria cristata*, Snowball Creek, Pagosa Springs, Colorado, E. Bethel, June 30, 1921, (type) associated with aecia on *Dugaldia Hoopesii* (A. Gray) Rydb.

PUCCINIA KOELERIAE Arth.

In 1920, two collections of telia of P. *Koeleriae* (*15720, 15820*) were received from Mr. Bethel who had collected them on *Koeleria cristata* at Pagosa Springs, Colorado, October 18. These were overwintered and were used to inoculate *Berberis canadensis, B. Fendleri, B. trifoliata, Mahonia Aquifolium,* and *M. repens.* Abundant infection was obtained on *Berberis Fendleri,* the others giving negative results. The infection on *Berberis Fendleri* was unusually abundant. Although in most cases the infection was localized and produced a limited mycelium, in some cases apparently very young buds were infected. As the buds developed, the mycelia spread throughout the leaves modifying their form, usually producing a compact rosette with pycnia and aecia developing throughout.

In the spring of 1922, one of the infected plants of the year before produced two short branches with leaves bearing pycnia distributed throughout. Apparently these originated from two of the infected buds of the previous season. Aecia did not develop. This plant was retained in the greenhouse and observed annually for seven years. Each year most of the new branches bore leaves showing pycnia. No aecia were produced after the first year. In the spring of 1928 an attempt was made to stimulate the production of aecia by mixing nectar from the pycnia. This was without result. Probably the two original buds from which the infected branches arose contained haploid mycelia of the same sexual strain.

The aecia (Ber. 6) produced in the spring of 1921 were used to inoculate *Agropyron caninum, A. Smithii, A. tenerum, Aira caespitosa, A. flexuosa, Arrhenatherum elatius, Avena fatua, Elymus canadensis, E. glaucus, E. striatus, E. virginicus, Holcus*

lanatus, Hordeum Gussoneanum, H. jubatum, H. vulgare, Hystrix Hystrix, Koeleria cristata, K. gracilis, Melica imperfecta, Oryzopsis miliacea, Poa palustris, P. pratensis, Secale cereale, Sitanion Hystrix, Sphenopholis obtusata, Trisetum sesquiflorum, and *Triticum vulgare*. *Koeleria cristata* and *Trisetum sesquiflorum* were very susceptible producing well developed uredinia and later telia. *Koeleria gracilis* was slightly infected producing small uredinia accompanied by necrosis. The other species showed little or no signs of infection.

Aecia collected by Mr. Bethel on *Berberis Fendleri* (Ber. 10) at Pagosa Springs, Colorado, June 29, 1921, were used to inoculate *Agropyron tenerum, A. Smithii, Elymus canadensis, Sitanion Hystrix,* and *Koeleria cristata* resulting in abundant infection on *Koeleria cristata* and negative results with the others.

Mr. Bethel also collected aecia on *Mahonia* (*Berberis*) *Aquifolium* at Pagosa Springs, June 30, 1921. The plants were heavily infected but the aecia were mostly young. Inoculation with this material on *Koeleria cristata* gave only slight infection. Reinoculation with the uredinia thus produced was not successful.

The species *Puccinia Koeleriae* was described by Aruthur (**1909**) as the result of an inoculation from telia on *Koeleria cristata* which produced aecia on *Mahonia Aquifolium*. The writer (**1921**) has shown that *Puccinia montanensis* has its aecial stage on *Berberis Fendleri*. The aecia of *P. Koeleriae* and *P. montanensis* and those produced by the cultures just described show no marked differences. The rust of *Koeleria cristata* connected with aecia on *Berberis Fendleri*, however, differs markedly from *Puccinia montanensis* both in morphology and in grass hosts and agrees very well with *P. Koeleriae*, differing principally in slightly thinner-walled paraphyses. The results obtained in these studies strongly suggest that there are two races of *P. Koeleriae*, one having aecia on *Mahonia Aquifolium* and the other with aecia on *Berberis Fendleri*.

The species, *Puccinia Koeleriae, P. Arrhenatheri* (Kleb.) Erikss., *P. montanensis,* and *P. glumarum* (Schmidt) Erikss. & Henn., form an interesting series. *Puccinia Koeleriae* has scattered uredinia with abundant paraphyses. *Puccinia Arrhenatheri* resembles *P. Koeleriae* very closely as far as its uredinia and telia

are concerned. The paraphyses of *Puccinia montanensis* are fewer, smaller and thinner walled than those of the two preceding. It, however, differs most markedly in that its uredinia and telia are arranged in more or less definite lines. *Puccinia glumarum* has few or no paraphyses. It resembles *P. montanensis* in the arrangement of its uredinia and telia in lines but differs in color of the urediniospores and size of the teliospores. *Puccinia Koeleriae, P. Arrhenatheri,* and *P. montanensis* all produce aecia on species of *Berberis* or *Mahonia.* The relationship indicated above suggests the possibility that the aecial host of *Puccinia glumarum* may also be some species of *Berberis* or *Mahonia.*

PUCCINIA INTERVENIENS Bethel.

Telia (*18520*) collected by Mr. Bethel on *Stipa pulchra,* Mill Valley, California, Sept. 24, 1920, were used to inoculate *Aster multiflorus, Sidalcea candida* and *Solidago rigida* in the spring of 1921. Pycnia followed by aecia were produced only on *Sidalcea candida.*

Another collection of telia (*18620*) obtained by Mrs. Clemens on a species of *Stipa* at Carmel, California, March 30, 1921, was received from Mr. Bethel. This was used to inoculate *Sidalcea candida* resulting in the production of pycnia and aecia. The aecia (Sid. 2) from this infection were used to inoculate *Oryzopsis miliacea, Stipa minor, S. pulchra, S. viridula,* and *Stipa* sp. *Oryzopsis miliacea, Stipa pulchra* and *Stipa* sp. were infected showing telia with a few urediniospores.

In September 1921 a collection of telia (*7221*) was received from Mr. Bethel. This consisted of a mixture of *Puccinia interveniens* and *P. substerilis* on *Stipa Lettermannii* collected Sept. 5, 1921, at Sulphur Springs, Colorado. The teliospores of *P. interveniens* were found germinable and were sown on *Sidalcea candida* resulting in the development of pycnia and aecia.

These results support the conclusions reached by Mr. Bethel both through his field observations and as the result of a number of cultures (Blasdale **1919**).

PUCCINIA MICRANTHA D. Griffiths.

Overwintered telia (*19220*) collected by Mr. Bethel, April 14, 1921, in the Garden of the Gods, Colorado, on *Oryzopsis micrantha*

(Trin. & Rupr.) Thurb., were used to inoculate *Aster multiflorus, Ribes aureum, R. Cynosbati, R. floridum, R. nigrum, R. oxacantha, Sidalcea candida,* and *Solidago rigida.* Pycnia developed on *Ribes oxacantha* and pycnia and aecia on *R. aureum.* The rest gave negative results. These results agree with Mr. Bethel's field observations which indicated a connection with aecia on *Ribes.*

PUCCINIA ANDROPOGONIS Schw.

Telia (*12020*) collected by H. S. Jackson at Shadeland, Indiana, Sept. 15, 1920, were overwintered and sown in April 1921 on *Linaria canadensis, Oxalis corniculata, Pentstemon hirsutus, P. secundiflorus,* and *Viola cucullata.* Pycnia and aecia developed only on *Pentstemon hirsutus.*

Telia (*12320*) collected by the writer on *Andropogon* sp. at Shadeland, Indiana, Sept. 15, 1920, were sown in April 1921 on *Linaria canadensis, Oxalis corniculata, Pentstemon hirsutus, Polygala Senega,* and *Viola cucullata* with development of pycnia only on *Pentstemon hirsutus.*

Telia (*13920*) collected by J. J. Davis on *Andropogon scoparius* at Muscoda, Wisconsin, Sept. 4, 1920, were used in April 1921 to inoculate *Linaria canadensis, Oxalis corniculata, Pentstemon hirsutus,* and *Viola cucullata* with the production of pycnia and aecia only on *Pentstemon hirsutus.*

Overwintered telia (*31319*) collected on *Andropogon scoparius* by H. D. House at Albany, New York, April 1920, were used to inoculate *Chelone glabra* and *Pentstemon secundiflorus.* A few pycnia developed on *Pentstemon secundiflorus.* Abundant pycnia and aecia developed on *Chelone glabra.*

Telia collected by the writer on *Andropogon scoparius,* at Ann Arbor, Michigan, Oct. 23, 1919, were sown on *Polygala Senega* in April 1920 with the production of abundant pycnia and aecia. Aecia collected by the writer on *Polygala Senega* at Ann Arbor, Michigan, in May 1932 were used to inoculate *Andropogon scoparius* with the production of uredinia and telia.

These results support those obtained by Arthur (**1900, 1904, 1906, 1907, 1912, 1915**), Long (**1912, 1914**) and Davis (**1926, 1929, 1931**). *Puccinia Andropogonis* produces aecia on *Amphicarpa monoica, Chelone glabra, Camandra umbellata, Lupinus perennis, Pentstemon hirsutus, Polygala Senega,* and *Zanthoxylum*

americanum. The rust of *Andropogon* connected by Long (**1912**) with aecia on *Oxalis* and placed by Arthur and Fromme (**1920**) in *Puccinia Sorghi* also apparently belongs here, thus adding species of *Oxalis* as aecial hosts for *Puccinia Andropogonis*.

Arthur and Fromme (**1920**) state that *Puccinia Andropogonis* contains two races separable by the families of the aecial hosts, Santalaceae and Scrophulariaceae as well as by slight morphological differences. These conclusions were based on the results of cultures in which aecia were produced on *Comandra umbellata* but not on *Pentstemon hirsutus* and *P. alpinus* by one race while aecia were produced on *Pentstemon alpinus* but not on *Comandra umbellata* by the other. The results of the studies reported here would indicate that the race having aecia on *Pentstemon* is also distinct from the rust going to *Oxalis* and *Polygala*. The cultures of Davis indicate that the rust with aecia on *Polygala Senega* is a separate race from that with aecia on *Amphicarpa monoica*. It is very probable that races occur specialized to *Amphicarpa, Polygala, Lupinus, Zanthoxylum, Oxalis, Comandra* and *Pentstemon* respectively. *Chelone glabra* may also be a host for the race with aecia on *Pentstemon*.

PUCCINIA ELLISIANA Thüm.

Telia (*125*) collected by the writer Sept. 25, 1925, at Lafayette, Indiana, on *Andropogon* species were sown in May 1926 on *Baptisia australis, Oxalis corniculata, O. europea, O. stricta, Pentstemon gentianoides, P. laevigatus,* and *Viola papilionacea*. Pycnia and aecia were produced in abundance on *Viola papilionacea,* the rest giving negative results.

Telia (*326*) collected by the writer at Lafayette, Indiana, in 1926 were sown in April 1927 on *Baptisia australis, Falcata comosa,* and *Viola papilionacea* resulting in abundant aecia on *V. papilionacea*. Another collection (*426*) from Lafayette, Indiana, was used to inoculate *Oxalis corniculata, O. europea, O. stricta, Polygala Senega, Falcata comosa, Baptisis australis, Viola affinis,*[3] *V. chinensis, V. glabella californica, V. incognita, V. nephrophylla, V. pallida, V. papilionacea, V. pinnata, V. sagittata, V. septentrionalis, V. sororia,* and *V. tricolor* (Giant White pansy). Pycnia

[3] Seeds of a number of the species of *Viola* were kindly supplied by Mr. A. Gershoy of the University of Vermont.

and aecia developed very abundantly on *Viola nephrophylla, V papilionacea, V. septentrionalis,* and *V. sororia.* A moderate development occurred on *Viola affinis* and *V. tricolor.* A few aecia were produced on *Viola pinnata.* Only pycnia occurred on *Viola chinensis, V. glabella californica, V. incognita,* and *V. sagittata.* No signs of infection were noted for *Viola pallida.*

Puccinia Ellisiana is very closely related to *P. Andropogonis.* It is separated by its specialization to species of *Viola* for its aecial hosts and by less pronounced morphological differences.

Long (**1912**) obtained pycnia and aecia on *Viola fimbriatula, V. hirsutula, V. papilionacea,* and *V. sagittata* from telia collected on *Andropogon virginicus* in Virginia. *Viola cucullata, V. pedata,* and *V. primulifolia* gave negative results.

Arthur (**1915**) obtained aecia on *Viola cucullata* and *V. Nuttallii* from telia collected in North Dakota. *Viola primulifolia, Laciniaria punctata,* and *Lithospermum angustifolium* gave negative results.

It is evident that the results obtained with *Viola cucullata* and *V. sagittata* are not in agreement. Arthur obtained aecia on *Viola cucullata* while Long had negative results. Long found *Viola sagittata* a favorable host while only pycnia were obtained in the studies reported here. This indicates either that several races occur or that there are strains of these species of violets differing in their reactions.

PUCCINIA WINDSORIAE Schw.

Telia (*19520*) collected by the writer on *Tridens flavus* (L.) Hitchc. Aug. 23, 1920, at Battle Ground, Indiana, were overwintered and sown in April 1921 on *Dirca palustris* and *Ptelea trifoliata* with the production of pycnia and aecia on *Ptelea trifoliata.* Arthur (**1900, 1903, 1905, 1916**) proved this connection with rust from Indiana and Texas. He was not able to infect *Dirca palustris, Zanthoxylum americanum,* or *Ambrosia trifida.*

PUCCINIA POLYGONI-AMPHIBII Pers.

The rust of *Polygonum virginianum* is of special interest since it is distinguished from that on other species of *Polygonum* by having subequatorial germpores in the urediniospores instead of superequatorial pores. It is of importance, therefore, to deter-

mine the aecial host of the rust of *Polygonum virginianum* in order to throw light on its relationship.

Telia of this rust collected on *Polygonum virginianum*, by L. E. Wehmeyer at Ann Arbor, Michigan, were overwintered and sown in May 1932 on *Geranium maculatum* resulting in abundant production of pycnia and aecia. The aecia thus obtained were used to inoculate *Polygonum virginianum* resulting in the production of abundant uredinia and later telia as the result of reinoculations. The urediniospores of the original collection as well as those produced from aecia were found to have subequatorial or sometimes approximately equatorial germpores.

The studies of Tranzschel (**1903**, **1905**), Arthur (**1905**, **1906**, **1907**), Klebahn (**1905**), Bubak (**1906**), Treboux (**1912**a, b), Jacob (**1916**) have shown that *Puccinia Polygoni-amphibii* contains a number of races which may be distinguished by specialization to both aecial and telial hosts. *Geranium maculatum*, the favorable aecial host for the North American rust gave negative results in all the European studies. The results of the latter investigations also indicate that there are a number of races in Europe which may be distinguished by the reactions of such species as *Geranium pratense*, *G. pusillum*, *G. phaeum*, and also by species of *Polygonum*. Although the rusts from *Polygonum emersum* and *P. virginianum* in North America both produce aecia on *Geranium maculatum*, they probably also are specialized to different species of *Polygonum* and should at least be considered different races.

UROMYCES ACUMINATUS Arth.

Telia (*13620*) collected by H. S. Jackson, October 5, 1920, at Riverside, Indiana, on *Spartina Michauxiana* were sown in March 1921 on *Polemonium reptans* and *Phlox divaricata* resulting in abundant pycnia and aecia on *Polemonium reptans* and a few pycnia on one plant of *Phlox*. Telia (*14420*) collected by H. S. Jackson, October 14, 1920, at Shelby, Indiana, on *Spartina Michauxiana* were sown in March 1921 on *Polemonium reptans* and *Phlox divaricata* resulting in the production of pycnia and aecia only on *Phlox divaricata*.

Arthur (**1906**, **1908**) obtained aecia on *Steironema ciliatum* from telia on *Spartina Michauxiana* collected in Nebraska. Negative

results were obtained with *Lysimachia quadrifolia, Polemonium reptans, Polygala Senega, Cassia Chamaecrista, Psoralea Onobrychis, Rudbeckia laciniata, Ambrosia artemisiaefolia, Thalictrum dioicum,* and *Viola papilionacea.* Collections (Arthur **1912**a) from North Dakota and Colorado produced aecia on *Polemonium reptans* while *Steironema ciliatum, Hydrophyllum capitatum* and *Phlox divaricata* gave negative results. A collection (Arthur **1915**) from Colorado produced aecia on *Collomia linearis,* while *Steironema ciliatum* and *S. lanceolatum* gave negative results.

It is evident, therefore, that *Uromyces acuminatus* contains a number of races distinguished by their specialization to species of *Polemonium, Phlox, Steironema* and probably *Collomia.*

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MYCOLOGICAL NOTES FOR 1930–32 [1]

L. O. Overholts

(with plates 45–47)

PHYCOMYCETES

1. Peronospora Ficariae Tul.

On living leaves of *Ranunculus recurvatus*. Lock Haven, Pennsylvania. (No. *14319*.)

Conidia broadly ellipsoid, hyaline, 22–30 × 16–24 μ.

2. Peronospora Hyoscyami DeBary.

On living leaves of *Nicotiana Tabacum*. Lancaster County, Pennsylvania. (No. *14602*.)

Conidia broadly ellipsoid to nearly globose, smooth, hyaline, 13–17 × 12–14 μ. Not widely reported in the United States until very recently.

3. Synchytrium plantagineum Sacc. & Speg.

On *Plantago virginica*. Pilot Knob, Missouri. May 21, 1927. (No. *12725*.)

This species was originally described from Spegazzini's collections in South America. Dr. Dearness has kindly communicated to me a small portion of a collection reported in the Tracy and Earle list of Mississippi fungi in 1895, on *Plantago lanceolata*. This is probably the only record of the occurrence of the species in this country.

[1] Publication authorized by the Director of the Pennsylvania Agricultural Experiment Station, February 3, 1933, as Technical Paper No. 580. Contribution No. 85, Department of Botany, The Pennsylvania State College, State College, Penna.

This paper is a continuation of a series, all under a similar title, that was begun in 1919, and published either in Mycologia or in the Bulletin of the Torrey Botanical Club. I am indebted to the following persons for aid in identification of some of the species: Miss Edith K. Cash and Mr. W. W. Diehl of the Office of Mycology, Washington, D. C., and Dr. J. Dearness, London, Ontario.

4. SYNCHYTRIUM STELLARIAE Fuckel.

On *Cerastium vulgatum*. Mine Lamotte, Missouri. May 14, 1926. (No. *12723*.)

Species of *Cerastium* are listed in the European literature as hosts for both *Synchytrium aureum* and *S. Stellariae* but that host has received little mention in this country. The Seymour host index lists the latter species on *Stellaria media* but not on *Cerastium*. Dr. Davis lists no fungi of this group on either host, nor have we found it in any other American list. In this collection it occurred in great abundance on both leaves and stems of *C. vulgatum*. The species is not in Maneval's list of Missouri fungi.

ASCOMYCETES

5. CRYPTODISCUS ANGULOSUS Karst.

On dead branches of *Salix*. Potter County, Pennsylvania. (No. *14495*.) FIGS. 1, 2.

Apothecia gregarious, circular to somewhat angular or slightly elongate, long covered by the epidermis, finally exposing the dark olivaceous disk bordered by the irregularly torn host tissue, the disk 1/3–1/2 mm. diameter; asci ellipsoid when mature, 8-spored, 35–55 × 11–16 μ; spores cylindric or slightly curved, smooth, hyaline, 4-celled, 14–24 × 3–3.5 μ; paraphyses linear, apparently branched at the tip to form an epithecium.

Dr. Dearness writes that *Propolidium fuscocinereum* Ellis & Ev. was indicated as a synonym by Rehm in 1912.

6. DERMATEA PRUNASTRI (Pers.) Fries.

On dead limbs of wild species of *Prunus*. Pennsylvania. (No. *15121*.) FIG. 7.

At first erumpent through the bark as spine-like or cylindrico-conic stromata, hard and brittle when dry, projecting for about 1 mm., with total length of 1400–1600 μ, 650–850 μ diameter at the base, in section short-columnar and sometimes abruptly constricted at the base; macroconidia hyaline, curved, pointed at the ends, 1-celled, 11–15 × 2.5–3 μ, produced in a single internal pycnidial cavity in the tip of the stroma; microconidia hyaline, 1-celled, cylindric, 6–7 × 1 μ, produced in superficial spermagonia on the exterior of the apex of the stroma; apothecia superficial, singly or

grouped on the apex of the stroma; asci clavate- cylindric, 60–80 × 8.5–10 μ, 8-spored; ascospores ovoid-elliptic to elongate, hyaline or nearly so, 1-celled, 7–10 × 3–4 μ.

Sphaeronema spurium (Fries) Sacc. is said to be the name of the macroconidial stage.

My specimens are evidently not quite mature, and that may account for the somewhat smaller measurements of the ascospores.

7. LACHNELLULA CHRYSOPHTHALMA (Pers.) Karst.

On dead twigs of *Pinus Banksiana*. Iroquois Falls, Ontario. (No. *15125*.)

With aspect entirely of a *Dasyscypha*; apothecia attached by a narrowed base, gregarious, singly or clustered in twos or threes, 1–2 mm. diameter when fresh, yellow or golden when wet, externally white hairy when dry, the hymenium golden but drying pale orange, the margin strongly incurved; asci cylindric, narrowed at the base, 50–75 × 5–7 μ, 8-spored; spores globose, uniseriate, smooth, hyaline, 4–4.5 μ diameter; paraphyses exceeding the asci, not enlarged at the apex, simple, 2 μ diameter.

The species seems to be unreported in the American literature dealing with the fungous flora of eastern North America, though reported by Seaver (Mycologia **3**: 64. 1911) as common in the Rocky Mountains.

8. MICROSPHAERA RUSSELLII Clinton.

On living leaves of *Oxalis*. Pennsylvania. (No. *15003*.)

One of the more uncommon species of powdery mildews. The spores are considerably smaller than recorded by Salmon, being 9–16 × 7–9 μ, but may not be mature.

9. PHYSALOSPORA RHODODENDRI (DeNot.) Rehm.

On living leaves of *Rhododendron maximum*. Lake Harmony, Carbon County, Pennsylvania. Sept. 4, 1921. (No. *12012*.) FIG. 10.

The following notes were made from this collection: Spots small and circular, sometimes confluent and somewhat irregular, 2–7 mm. diameter, dirty brown with a somewhat darker raised margin, the center sometimes gray; perithecia epiphyllous, sparse, often invisible to the unaided eye, rather deeply imbedded in the meso-

phyll of the leaf, with ostiole definitely protruding to form a small black papilla, rather elongate and sac-like, about 270 × 150 μ; asci large, saccate with ends obtusely pointed, 90–120 × 30–36 μ; spores biseriate, 8 per ascus, ellipsoid, one-celled, hyaline or slightly yellowish, granular, thick-walled, 25–42 × 14–15 μ; paraphyses none.

10. TYMPANIS SALIGNA Tode.

On dead twigs of *Salix*. Cross Fork, Potter County, Pennsylvania. May 28, 1932. (No. *14314*.)

Asci 120–190 × 15–20 μ, with countless bacilliform spores, 3–3.5 × 0.75–1 μ. Paraphyses linear, not enlarged at the tips, simple, 1.5 μ diameter. Apothecia ⅓–¼ mm. diameter.

In all of these points the collection departs from the descriptions which call for smaller asci, paraphyses enlarged at the tips to 5 μ, branched; apothecia larger (0.5–1.5 mm.).

Other species of *Tympanis* not previously reported in these notes are:

Tympanis acerina Peck. On dead *Acer rubrum*; Pennsylvania and New Hampshire. (No. *11264, 12185*.) Seaver (Mycologia **25**: 144. 1933) records this name in synonymy under *Pezicula acericola*.

Tympanis alnea (Pers.) Fries. On dead *Alnus*; Pennsylvania. (No. *10960*.)

Tympanis Pinastri Tul. On dead *Pinus Strobus*; Pennsylvania. (No. *14325, 14981*.) On *Cronartium ribicola* canker on *Pinus Strobus*; New York. (No. *9408*.) On *Abies balsamea*; Pennsylvania and New Hampshire. (Nos. *8609, 5037*.)

11. VALSA ETHERIALIS Ellis & Ev.

On dead branches of *Acer rubrum*. Huntingdon County, Pennsylvania. March 1, 1930. (No. *12178*.)

While the original description is extremely meager, giving only the size of the perithecia, asci, and spores, the agreement of my material on all these points, and the great differences when compared with other species described on the same host, makes it quite probable that my material is correctly referred. Asci measure 15–24 × 4–6 μ, 8-spored; spores allantoid, hyaline, 5–6 × 1 μ.

FUNGI IMPERFECTI

12. CERCOSPORA ELONGATA Peck.

On leaves of *Dipsacus sylvestris*. Greenbush, Ohio, 1926, and Huntingdon County, Pennsylvania, 1932. (No. *12991, 14599*.)

The species rarely appears in local lists of fungi. My specimens could hardly agree better with Peck's description. Spores 60–120 × 4–4.5 μ, with a few indistinct septa. The fungus inhabits definite ashen-brown spots and fruits on the upper surface of the leaves.

13. DENDRYPHIUM TORULOIDES (Fres.) Sacc.

On dead stems of *Solanum dulcamarum*. Pennsylvania. (No. *14927*.) FIG. 8.

Forming a broad strigose mat of blackish hairs (conidiophores) on surface of stem, these erect, straight, septate, 200–400 × 9–12 μ, branched somewhat at the apex with short branches that cut off spores, presumably in chains; conidia elongate, with rounded ends, 2–5-septate, dark brown, slightly constricted at the septa, 15–28 × 6–7 μ.

Species of this genus are rarely collected.

14. DINEMASPORIUM PATELLUM Cooke & Ellis.

On dead stems of *Phytolacca decandra*. Center County, Pennsylvania. (No. *14232*.) FIG. 3.

With aspect of a setose *Lachnea* in every respect under a lens, 1–2 mm. diameter, dark brown with black hairs; conidia elongate, straight or crescent-shaped, hyaline, 1-celled or appearing 2-celled at times, both ends inconspicuously appendaged with a short hyaline bristle, the spore body 16–24 × 1.5–2 μ.

D. Pezicula Berk. & Curt. may not be distinct.

15. FUSICOCCUM PERSICAE Ellis & Ev.

Little has been written concerning this fungus and the possibility of its parasitism on *Prunus Persica*. At least it is not generally recognized as a menace to the peach tree. The species was originally described from Louisiana. In 1922 a specimen came into my hands from J. C. Dunegan, at Fort Valley, Georgia. In February 1931, it was collected in Adams County, Pennsylvania, by R. S. Kirby, on peach trees that had been obtained from the

south. The fungus may not be parasitic but the evidence could be taken to indicate that it is the cause of the death of the twigs, producing an injury similar to that usually associated with *Valsa leucostoma*. The spores measure 20–24 × 4–6 μ, and therefore over-run slightly the measurements given in the original description.

16. ISARIA UMBRINA (Pers.) Fries.

Forming pulverulent, pale cinnamon, clavarioid coremia about 1 mm. high, over the surface of *Hypoxylon* stromata. Spores pale brown, ovoid or elliptic, 3–4.5 × 2.5–3 μ.

Saccardo gives *I. acariforme* Fries as a synonym, under which name apparently this species was distributed by Ellis in N. A. Fungi no. *1328*, and by Ellis & Everhart in Fungi Columb. no. *2036*.

In my specimens the coremia are not dichotomously branched—in fact are usually simple—in contrast to the figure and description given in Rabenhorst's Kryptogamenflora, where it is described in two places, once under the above name and once as *Trichosporium umbrinum* (Pers.) Lindau. Four Pennsylvania collections have been incorporated into the herbarium.

17. MACROPHOMA CORNINA (Peck) Sacc.

On dead twigs of *Cornus Amomum*. Huntingdon County, Pennsylvania. (No. *13795*.)

Spores yellowish or smoky, smooth, short-cylindric or oblong, one-celled, content granular, 22–32 × 9–14 μ; pycnidia 200–280 μ diameter.

Perhaps better placed in *Sphaeropsis* than in *Macrophoma*. Reported on two other species of *Cornus* in the Seymour Index.

18. PHOMA SPERMOIDES Dearness.

On dead stems of *Thalictrum*. Pennsylvania. (No. *14928*.) FIG. 9.

Described first in Mycologia **16**: 160. 1924, from New York. On some of the stems all of the pycnidia are collapsed at the summit so as to appear disk-shaped and simulating a leptostromaceous pycnidium. They are sub-epidermal in origin but by weathering away of the fibrous outer cortex tissue finally may appear superficial.

19. RAMULARIA IMPATIENTIS Peck.

On leaves of *Impatiens pallida*. Clinton County, Pennsylvania. 1929. (No. *12138*.)

The collection yielded the following notes:

Spots circular or irregular, 2–13 mm. diameter, at first deep purplish-red all over, the center soon rusty-brown to brown and in the largest spots the red-purple margin completely disappearing; conidiophores short, fascicled, epiphyllous or amphigenous, forming a minute scurfiness over the surface of the spot; conidia cylindric or short-cylindric, hyaline, 1-celled, 10–21 × 3.5–5 μ.

20. SEPTORIA CALLISTEPHI Gloyer.

Early in September of 1930 Doctor G. L. Zundel brought in specimens of Chinese aster heavily infected with a *Septoria*. The specimens were collected in a nursery near Reading, Pa., and the loss in a ten-acre tract of the asters was said to be almost entire. The major part of the leaf tissue was dead and the plants were reported as dying rapidly. Examination showed the parasite to be near if not identical with *Septoria astericola* Ellis & Ev. Specimens sent to Dr. Dearness were identified as probably *S. Callistephi*, and the meager data given by Gloyer (Phytopath. **11**: 50. 1921) seems to agree. It is not improbable that these names are to be regarded as synonyms. Certainly if this collection be *S. Callistephi* there is little to separate it from the first-named species. The pycnidia in this collection measure 90–100 μ diameter and the spores are slightly curved, hyaline, multi-guttulate, the number of cells indistinct, and measure 25–45 × 1.5 μ. (No. *12403*.)

21. SEPTORIA CERASTII Rob. & Desm.

On leaves of *Cerastium vulgatum*. Mine Lamotte, Missouri. 1927. (No. *12724*.)

Probably this fungus is not uncommon on *Cerastium* and perhaps other Caryophyllaceous hosts. It is listed by both Davis from Wisconsin and by Schwarze from New Jersey. It is a very inconspicuous fungus and seems to cause no necrosis of host tissues, but the pycnidia appear crowded or gregarious on slightly paler areas on the upper surfaces of the leaves. They are globose or slightly compressed-globose, thin-walled, and 60–100 μ diameter.

The spores are linear, straight or nearly so, and measure 26–40 × 1 μ. The species is not found in Maneval's list of Missouri Fungi.

22. **Septoria Hypoxi** sp. nov.

Spots irregular, following the veins or along the midrib, limited by the larger veins, elongated, blackish and water-soaked; pycnidia amphigenous, blackish, 100–140 × 85–100 μ, with a definite blackish wall, sub-epidermal; spores linear, nearly straight or slightly curved, hyaline, apparently 1-celled, 25–40 × 1–1.5 μ.

On living leaves of *Hypoxis hirsuta*. Type collected in Shingletown Gap, Center County, Pennsylvania. June 18, 1932. (No. *14357*.) FIG. 5.

I find no record of a *Septoria* on *Hypoxis*. *Cylindrosporium guttatum* Winter is described as with spores 53–70 × 2 μ. My collection is definitely a *Septoria*.

23. SEPTORIA PODOPHYLLINA Peck.

On leaves of *Podophyllum peltatum*. St. Francois River, southern Missouri. 1927. The species is not in Maneval's list, and appears to be a much less common fungus than the *Phyllosticta* on the same host. Two collections are also at hand from Pennsylvania. Spores mostly 3-septate, straight or slightly curved, 24–50 × 1.5–3 μ.

24. SEPTORIA SIBIRICA Thüm.

This little known species was discovered in a student collection on plant diseases made in central Pennsylvania in 1921, on *Ribes vulgare*. The fruiting body in this case is an acervulus or a very imperfectly developed pycnidium as in the case of specimens collected by J. J. Davis and described by him as *Cylindrosporium Ribis* (Trans. Wisc. Acad. Sci. **16**: 759. 1909). Later he admitted that his species was referable, in its better developed forms, to *Septoria sibirica* and he distributed specimens under that name. Fungi Columbiani No. *4625* distributed as *C. Ribis* belongs here.

The species seems to differ from *Septoria Ribis* Desm. in the smaller size of the fruiting structures and in the considerably longer spores. My spore measurements from the Pennsylvania collection are 21–75 × 2 μ, while the fruiting bodies measure but 30–45 μ diameter.

25. SEPTORIA SPECULARIAE Berk. & Curt.

On leaves of *Specularia perfoliata*. Mine Lamotte, Missouri. 1927. Olivet, Armstrong County, Pennsylvania. 1931. (No. *12975, 13885.*)

The fungus fruits abundantly on the under surface of the dying lower leaves, not producing definite spots. The Pennsylvania collection showed pycnidia also on the stem and calyx. The spore characters of the two collections are in close agreement, 3-septate, 24–50 × 2–2.5 μ. Previously reported from both Missouri and Pennsylvania and found in several check lists in this country.

26. SEPTORIA VIRIDITINGENS Curt.

On living leaves of *Allium tricoccum*. Potter County, Pennsylvania. (No. *14993.*)

A very characteristic species, the diseased areas with a greenish tinge, later whitening at the center; pycnidia numerous, brown, 90–105 μ diameter; spores straight or slightly curved, 25–50 × 1–1.5 μ, several septate, hyaline. *S. alliorum* West. is usually listed as a synonym.

BASIDIOMYCETES

27. ALEURODISCUS FARLOWII Burt.

On dead branches of *Tsuga canadensis*; Pennsylvania. (No. *14233, 14512.*)

Burt records this species only from New Hampshire and New York.

Other species of *Aleurodiscus* collected or received in recent years are:

Aleurodiscus acerinus (Pers.) Höhn. & Lit. On the bark of living trees of *Acer, Carya, Fraxinus,* and *Quercus.* New Hampshire, Vermont, Pennsylvania, Florida, and Missouri. A common species.

Aleurodiscus amorphus (Pers.) Rab. On dead *Abies balsamea*; Ontario, New Hampshire, New York, Idaho, and Manitoba. On *Picea* twigs; Colorado.

Aleurodiscus candidus (Schw.) Burt. On the bark of living trees of *Carya, Fraxinus,* and *Quercus.* Pennsylvania, Ohio, and Missouri. A common species.

Aleurodiscus cerussatus (Bres.) Höhn. & Lit. Manitoba.

Aleurodiscus nivosus (Berk. & Curt.) Höhn. & Lit. On bark of living *Juniperus*. Massachusetts, Pennsylvania, Georgia, Ohio, and Indiana. A common species.

Aleurodiscus Oakesii (Berk. & Curt.) Cooke. On bark of living trees of *Carya, Ostrya,* and *Quercus*. Pennsylvania and Missouri. A common species.

Aleurodiscus penicillatus Burt. On *Pseudotsuga taxifolia*. Oregon.

28. CORTICIUM SULPHUREUM Fries.

On rotten *Quercus* log. Pennsylvania. (No. *14231*.) FIG. 4.

This collection adds a fifth state to those reported by Burt. It is a rare species, tender and hypochnoid in structure, at first mustard-yellow with a few sulphur yellow mycelial cords, the hymenium whitening at maturity, and in this character separable from *C. bicolor* Peck. Spores 3–3.5 × 2–3 μ, broadly ellipsoid, smooth, hyaline.

29. NYCTALIS ASTEROPHORA Fries.

On old decaying pileus of *Russula*. Pennsylvania. (No. *14607*.)

In my last series of these notes I recorded the finding of *N. parasitica* (Bull.) Fries, probably for the first time in America. The past season both of these species were brought in from the same locality near State College on the same day. The entire context of *N. asterophora* is transformed into a powdery mass of warted chlamydospores. I secured photos of both collections and they are reproduced herewith. FIGS. 11, 15.

30. PANUS OPERCULATUS Berk. & Curt.

On dead *Alnus* and *Betula*. Ontario and Pennsylvania. (No. *15025, 13878*.) FIG. 13.

Sporophore inversely cupulate or pezizoid and affixed by a short dorsal stalk or tubercle or laterally sessile, tough, reviving when moistened, more or less fox-color or rufous when wet, drying grayish or whitish, 3–6 mm. long, 3–10 mm. broad, covered with a short white pubescence that is more apparent on drying; margin incurved; context very thin, tough, in section showing 3 layers,

a superficial tomentose layer, an underlying narrow cuticular layer, and the broader context layer, none of these gelatinized; gills radiating from a lateral point, reddish, very narrow, medium close; spores allantoid, smooth, hyaline, 3.5–4 × 1–1.5 μ; cystidia none.

Older descriptions mention a fugacious veil over the gills of young specimens. My material includes young specimens but none show such an organ. The species is rare but probably widely distributed in eastern Canada and the Appalachian region.

31. PSATHYRA ECHINATA (Fries) comb. nov.

On waste heap in woods. State College, Pennsylvania. (No. *14897.*) FIG. 14.

A well-marked species of small size, with umber-brown, dry, minutely granulose-warted pileus, free and deep-red gills, and a well developed veil that soon breaks, leaving fragments only on the margin of the pileus. Its affinities are much in doubt. It has been placed in *Agaricus* (*Psalliota*), *Pholiota,* and *Inocybe,* but fits well in none of these genera. The spores in mass are smoky-brown with a distinct red tinge. Possibly *Hypholoma vinosum* Kauffman is the same plant, but his plants grew on wood and are said to have adnate-seceding gills. In Europe it is said to grow in greenhouses, and Kauffman describes plants under the name *Psalliota echinata* from such a habitat. My plants were collected in a woodlot adjoining the campus, where refuse from the greenhouses is dumped. Ricken's illustration (*pl. 31, fig. 6*) as *Inocybe,* represents our plant fairly well.

32. STEREUM PINI Fries.

On dead twigs of sapling *Pinus Strobus.* Several collections from Pennsylvania and one from Quebec. FIG. 12.

Burt records this species only from Maine and New Hampshire. Although long unrecognized, it has proved to be common in Pennsylvania on branches of white pine killed by the drought in the last few years. Burt's description is ample but his illustrations are not adequate.

33. TULASNELLA IN PENNSYLVANIA

Three species of *Tulasnella* have been incorporated into my herbarium in the last few years.

T. Eichleriana Bres. proves to be rather common, five collections having been entered to date, all from Pennsylvania. Wood of *Populus, Betula,* and *Quercus* represents the substrates. The color is gray to smoky olivaceous or with a pinkish tinge, and the aspect is that of a pale thin *Corticium* or *Hypochnus.* Because of the small size of basidia and epibasidia it is a critical species with which to work. See notes by Martin on species of this genus in Iowa (Univ. Iowa Stud. Nat. Hist. **13**[5]: 4–9. 1931).

T. fusco-violacea Bres. I have a single collection from New Hampshire on bark of *Abies balsamea.* This species resembles *Corticium vagum* but is less hypochnoid, and has cylindric spores 7–13 × 3–4 μ.

T. violea (Quél.) Bour. & Galz. Five collections are in my herbarium, all from Pennsylvania, on *Acer, Carya, Fagus,* and *Nyssa.* This is an easy species to study since the basidia, epibasidia, and spores are large enough to be made out satisfactorily.

34. VELUTICEPS FUSCA Humphrey & Long.

Collected on charred wood in the Black Hills of South Dakota, Aug. 7, 1929, by Seaver, Henderson, and Shope. This extends the range of this little known species, it having previously been reported only from Arizona, New Mexico, and Washington. Superficial examination would class the species as a member of the Hydnaceae because of the fascicles of protruding hyphae over the hymenium. But these fascicles are sterile, and therefore the same type of emergences as cystidia, setae, and hyphal pegs. While described as composed of brown hyphae as in other species of the genus, the hyphae that make up these fascicles are brown only when seen in mass, the isolated individuals appearing hyaline. (No. *12117.*)

STATE COLLEGE, PENNA.

EXPLANATION OF PLATES

PLATE 45

1. *Cryptodiscus angulosus.* Section through apothecium. × 125. (No. *14495.*)
2. *Cryptodiscus angulosus.* Ascus with spores. × 800. Spores × 1400. (No. *14495.*)
3. *Dinemasporium patellum.* Section through fruiting body. × 175 Spores × 290. (No. *14232.*)

4. *Corticium sulphureum.* Section through sporophore. × 200. Spores × 700. (No. *14231.*)

5. *Septoria Hypoxi.* Section through pycnidium. × 180. Spores × 500. (No. *14357.*)

6. *Stereum Pini.* Section through sporophore. × 370. (No. ——.)

7. *Dermatea Prunastri.* Vertical section of stroma bearing apothecia. × 240. (No. *14458.*)

8. *Dendryphium toruloides.* Conidiophore and conidia. × 450. (No. *14927.*)

9. *Phoma spermoides.* Section through pycnidium. × 100. Conidia × 660. (No. *14928.*)

10. *Physalospora Rhododendri.* Section through leaf bearing a perithecium. × 100.

PLATE 46

11. *Nyctalis asterophora.* Fruiting on old *Russula* sporophore. × 1. (No. *14607.*)

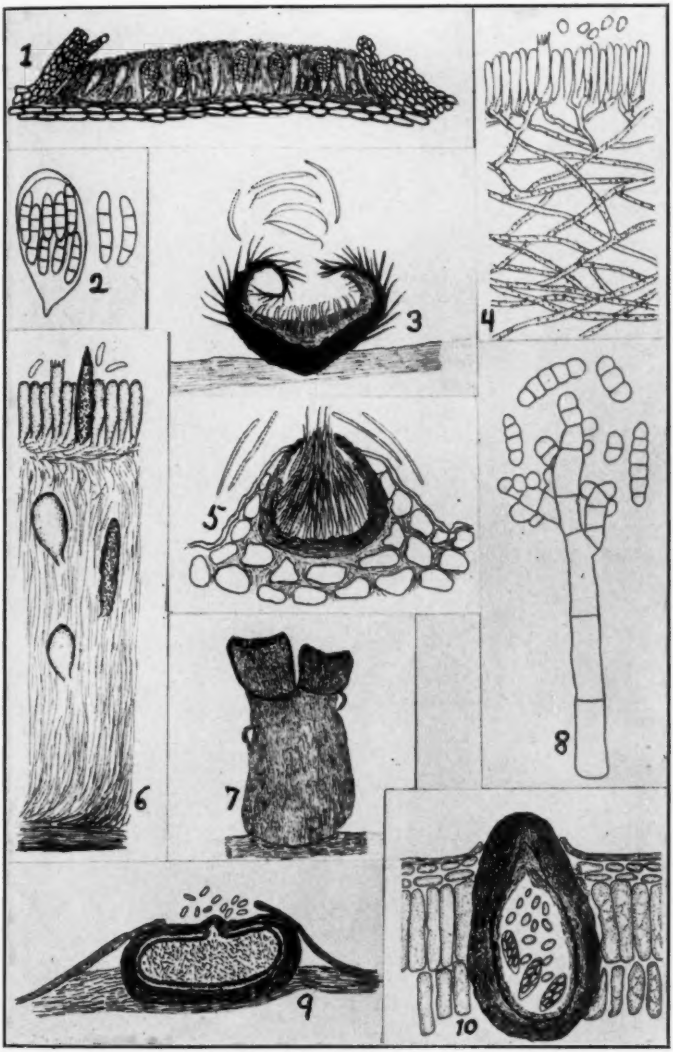
12. *Stereum Pini.* Sporophores on branches of *Pinus Strobus.* × 1. (No. *14458.*)

13. *Panus operculatus.* Sporophores on branch of *Betula.* × 1. (No. *15002.*)

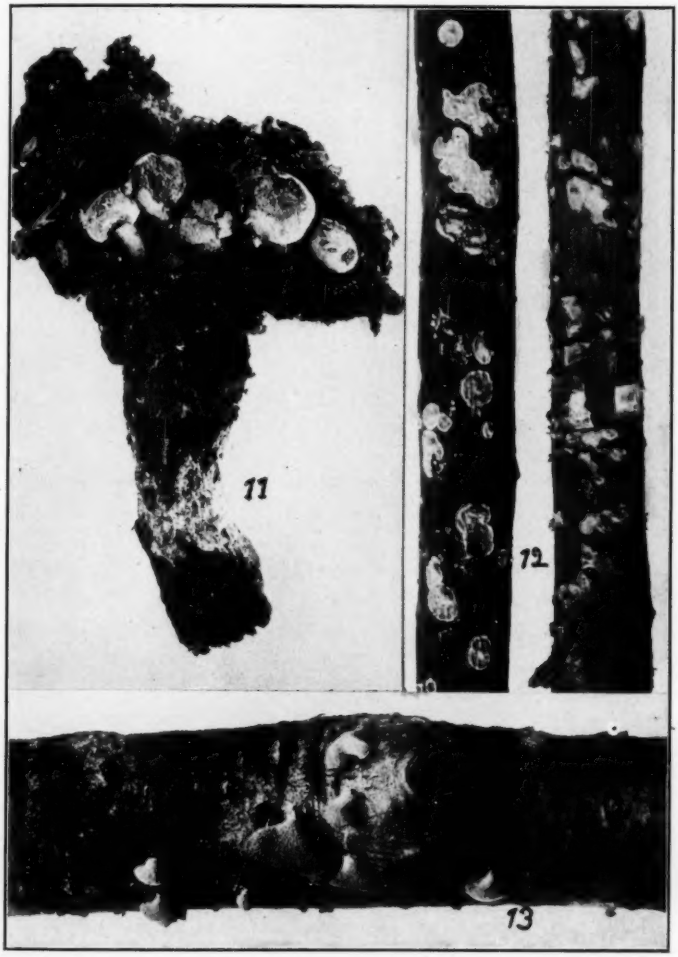
PLATE 47

14. *Psathyra echinata.* × 1. (No. *14897.*)

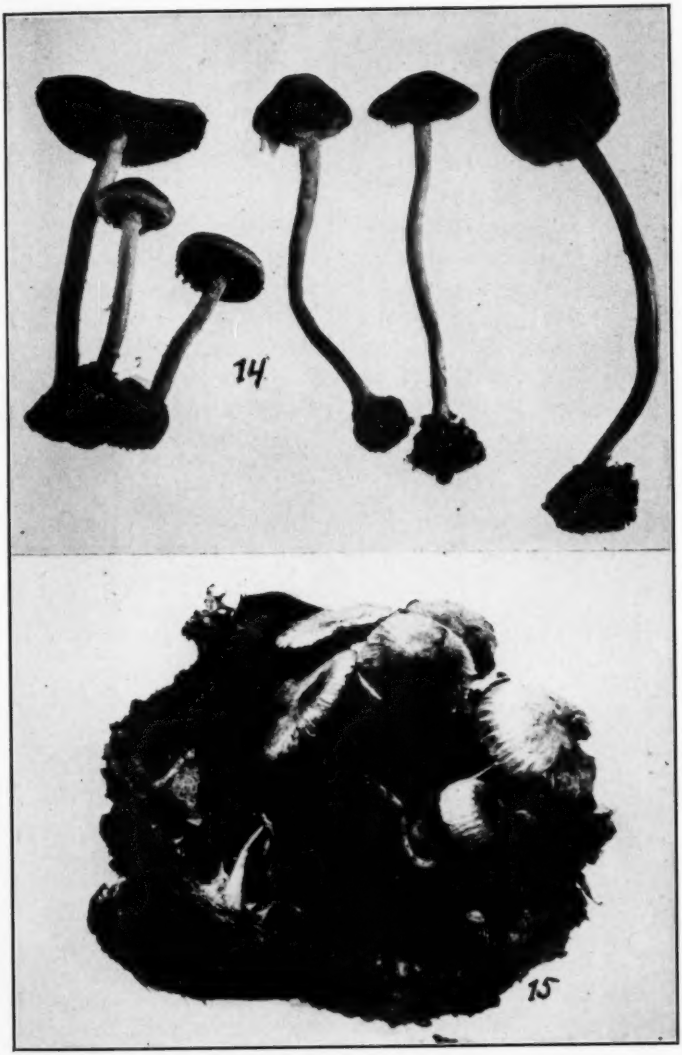
15. *Nyctalis parasitica.* Cluster of sporophores fruiting on old *Russula* sporophore. × 1. (No. *14579.*)



PENNSYLVANIA FUNGI



NYCTALIS ASTEROPHORA
STEREUM PINI
PANUS OPERCULATUS



PSATHYRA ECHINATA
NYCTALIS PARASITICA

ABNORMAL SPORES OF SOME GANODERMA

S. R. Bose

(WITH 3 TEXT FIGURES)

The upper surface of the sporophore of *Ganoderma lucidum* (Leyss) Fries always becomes covered with a laccate crust which when sectioned shows a number of deep-brown elongated basidium-like cells in close clusters.

Some fructifications of *Ganoderma lucidum* obtained from the Burdwan Dt. (Bengal) in September 1930 showed in the microscopical sections of the hymenial surface (FIG. 1, 2) very promi-

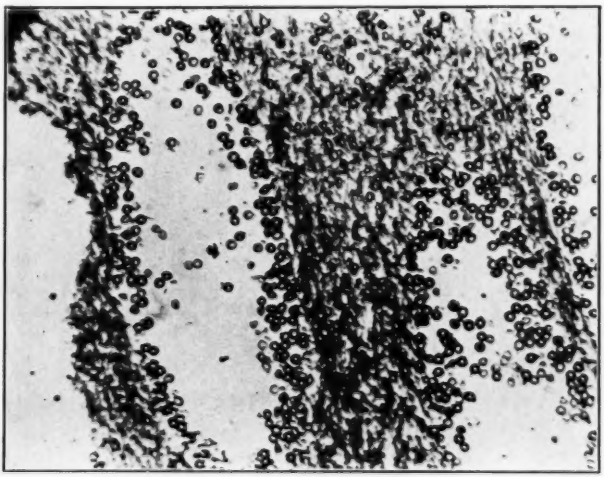


Fig. 1. Microphotograph of the longitudinal section of pore-tubes.

nently a large number of brown thick-walled big round and slightly elongated spores lining the pore-tubes, besides the basidia bearing the basidiospores; some of the pore-tubes were practically filled with such spores, here and there they were collected *enmasse* as spore-balls within the cavities of the pore-tubes; they were also

spread within the trama and the context of the sporophores. Such spores measuring 12 to 16 μ in diameter show close striations within their thick walls and their bodies are finely reticulated. The hymenial surface of these specimens showed the formation of laccate crust in patches completely effacing the porous areas here and there. A longitudinal section of this crust (FIG. 3) showed the same elongated basidium-like deep-brown cells in clusters, which normally occur on the upper surface of the fructi-

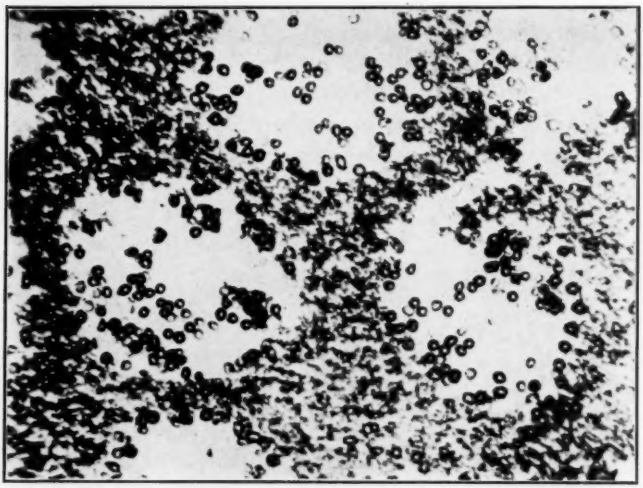


Fig. 2. Microphotograph of the transverse section of pore-tubes.

fications; adjoining the row of elongated cells was a number of the same brown thick-walled globose spores dispersed here and there within the flesh.

Subsequently in November 1931, I collected a specimen of *Ganoderma applanatum* Fries from Kurseong (Darjeeling), within the hymenial surface of which the same double-walled spores can be seen in large number.

In 1928 Malençon and Heim (**1**) described *Ganoderma rivulosum* Pat. and Hariot from Tonkin, in a longitudinal section of the pore-tube of which they have figured a number of such thick-walled globose spores which they have named "gasterospores,"

they are exactly like the spores of my specimens in shape and size, only their bodies are not verrucose as noted by them, but are finely reticulated. In *Ganoderma colossum* Fries, Patouillard (**2**) noted in 1887 such formation as internal conidia similar to the production of the Ptychogaster stage.

Incidentally, I may record that in the present case as also in the course of my work on Polyporaceae I have seen that the Leishmann's stain largely used in Protozoology brings out a sharp differentiation between the basidia on the one hand and the tramal-

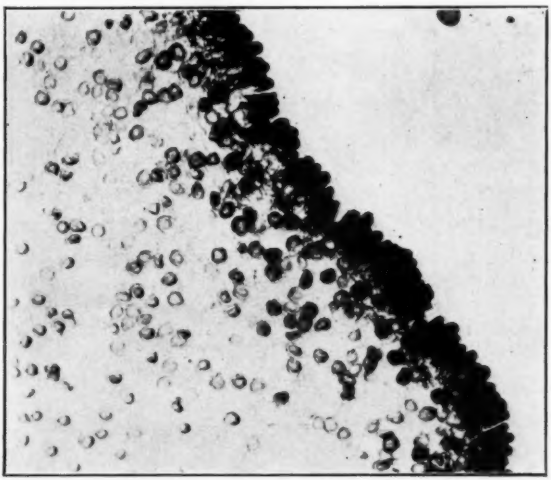


Fig. 3. Microphotograph of the longitudinal section of the crust.

and context-hyphae on the other in cases of dried specimens. Basidia become colored violet, and the tramal- and context-hyphae take on a deep-blue stain; in the case of dark and brown specimens (*i.e., Hexagonia, Fomes,* etc.) the tramal- and context-hyphae are colored green. It is a very quick stain, the whole process is completed in about 10 to 15 minutes' time.

It may be used as follows:

I. Take a clean slide thoroughly washed in sterilized distilled water.

II. Drop Leishmann's stain from a 30 c.c. dark drop-bottle on the slide till the section is fully covered. Wait for ½ minute only.

III. At the end of ½ minute drop on to the slide double the corresponding number of drops of sterilized distilled water. By tilting the end of the slide allow the stain and water to mix thoroughly. Stain for about 5 to 10 minutes only.

IV. Wash the section in tap or distilled water thoroughly in a porcelain cup. This takes about 3 or 4 minutes. By means of a brush transfer the section to the slide which has been cleaned in the meantime.

V. Now place the slide leaning against a vertical wall to dry.

VI. After the slide is dried, put a drop of cedar-wood oil on the section and finally mount in xylol and balsam.

It does not seem to be a very permanent stain, usually it keeps good for about a year.

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2. **Patouillard, N.** Contribution à l'étude des Champignons extra-européens. Bull. Soc. Myc. Fr. **3**: 119–131, *pl. 9–11.* 1887.